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ENTION NUMBER

NOVEMBER, 1936

Railway Engineering Maintenance

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Number THIRTY-SEVEN

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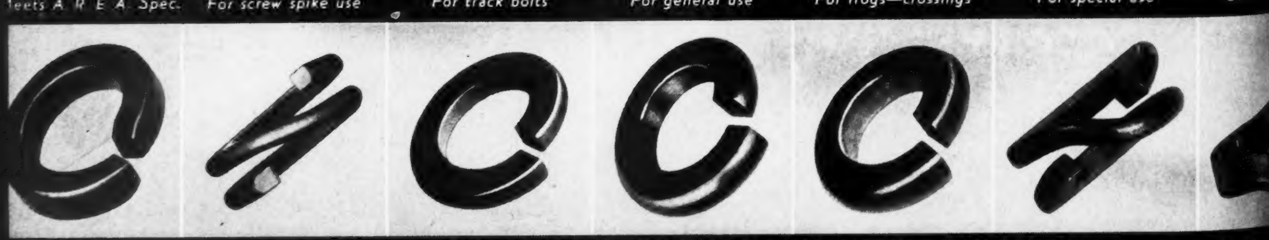

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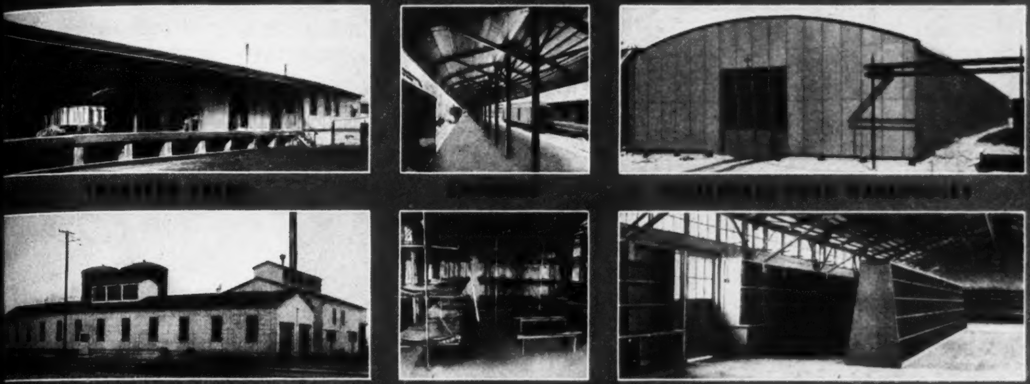

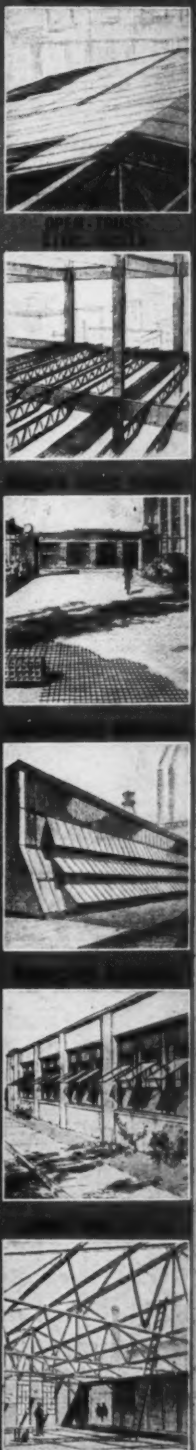

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The illustrations on this page only "scratch the surface" of Truscon Service to railroads. All we can hope to accomplish in this limited space is to leave you with the impression ... *and it is a correct impression* ... that Truscon Steel Company is qualified to assist you in meeting your responsibilities on a vast number of railroad projects.

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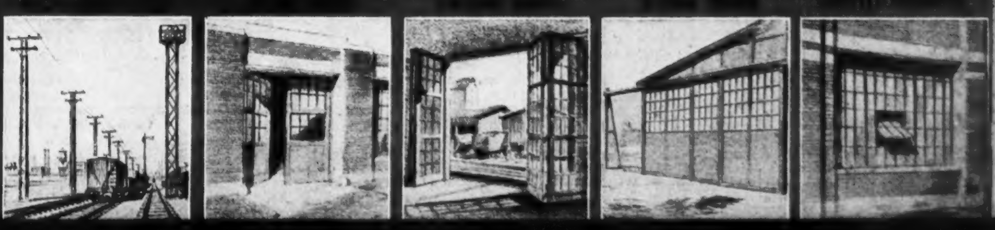

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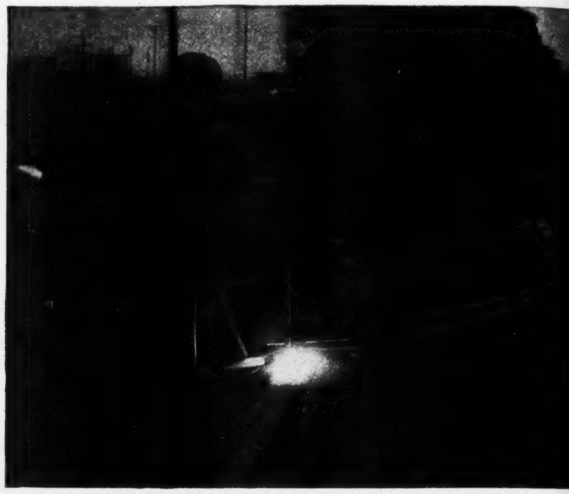
(U. S. Patent 1,815,464)



AMSCO Nickel Manganese Steel Welding Rod is easy to apply. The deposit rapidly work-hardens under impact, does not scale or spall off, requires no quenching, and gives a tough impact and abrasion resisting surface with a ductile backing, comparable to that of heat-treated, austenitic manganese steel.

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AMSCO Nickel Manganese Steel Welding Rod is stocked by all AMSCO foundries and distributors everywhere — in 1/8", 5/32", 3/16", 1/4" and 5/16" diameters, coated and bare, 14" and 18" lengths; and in coils.

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BUDGET MAKING TIME

TO RAILWAY SUPPLY MANUFACTURERS

"When the frost is on the punkin"

"When the frost is on the punkin," much of the year's work on the tracks and structures draws to a close. In its place loom the programs for the next year.

Maintenance officers are now completing their fall inspections to determine what they will do and what they MUST do next year.

Six years of undermaintenance cannot be ignored. Neither can the increasingly exacting demands of tomorrow's traffic—to say nothing of the necessity for making good current wear and tear.

With gross operating revenues running 20 per cent ahead of last year and net operating income 50 per cent greater, larger programs are in the making.

Maintenance expenditures this year are 17 per cent larger than last year—they will be still larger next year.

Yet the needs are so great that, with even the most optimistic outlook, the money available will not be sufficient to meet all the demands. The problem confronting maintenance officers is one of selection.

Are you telling the story of your products and of the economies they will effect to those subdivision, division and system maintenance officers who are now laying out their programs for next year and selecting the materials, tools and equipment needed therefor?

Are you including as an essential part of your 1937 sales program representation for your products in the magazine which these maintenance men read first of all?

RAILWAY ENGINEERING AND MAINTENANCE IS READ BY MAINTENANCE OFFICERS OF ALL RANKS

Breaking up cemented ballast to depth of tool with BARCO UNIT TYTAMPER. Note loosened ballast between tracks and at end of ties, also depth to which tamper has penetrated.

Breaking up cemented ballast quickly and efficiently is only another of the jobs that the BARCO PORTABLE GASOLINE UNIT TYTAMPER does better.

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The BARCO UNIT TYTAMPER easily forces the tool all the way to the bottom of the ballast insuring a complete job.

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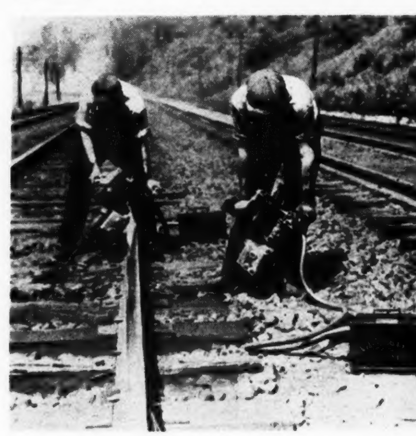

Two Tytampers at work on cemented cribs showing ballast as loosened up.

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No. 95 of a series

Railway Engineering and Maintenance

SIMMONS-BOARDMAN PUBLISHING COMPANY

105 WEST ADAMS ST.
CHICAGO, ILL.

Subject: Constant Repetition

October 29, 1936

Dear Reader:

"I haven't bothered you for the last three or four years, for I knew that you were doing so little work that I have assumed that you have not been in the market for any of our material." This was the greeting extended to the chief maintenance officer of a large railway by the sales representative of a railway supply company when calling on him a short time ago. "Yes, it has been a long time since I have seen you", countered the railway officer, "but I did place an order a short time ago with another concern for some $50,000 worth of your product—and I do not recall that you were even on our inquiry list. In fact, I forgot all about your company, for you have not been calling on me and I do not recall having seen your advertising of late."

Perhaps this may sound like an unusual instance. It is in a way. Yet it can be duplicated more frequently than one might expect, even among companies with well organized sales staffs that are constantly on the alert. It illustrates a breakdown in what every sales manager recognizes as one of the basic principles of salesmanship—that a company must keep its product continually before its customers if it is to insure that it will receive consideraton <u>whenever</u> the customer is in need of his product. This is a service that the advertising pages of a publication like Railway Engineering and Maintenance render a manufacturer for it enables him to remind you every month of the fact that he is prepared to serve you. And the service is equally valuable to you railway men who turn to the advertising pages when in need of material to insure that you will not overlook some product or some manufacturer.

In this busy industrial age the demands upon our time are so great that we all tend to forget companies and products which are not kept constantly before us. And one must not overlook the fact also that new men are constantly coming into positions of responsibility who must be educated to the merit of one's product. It is because of these facts that advertising has come to occupy such a large place in modern salesmanship. The selling of railway materials is no exception.

Yours sincerely,

Elmer T. Howson

ETH*JC Editor

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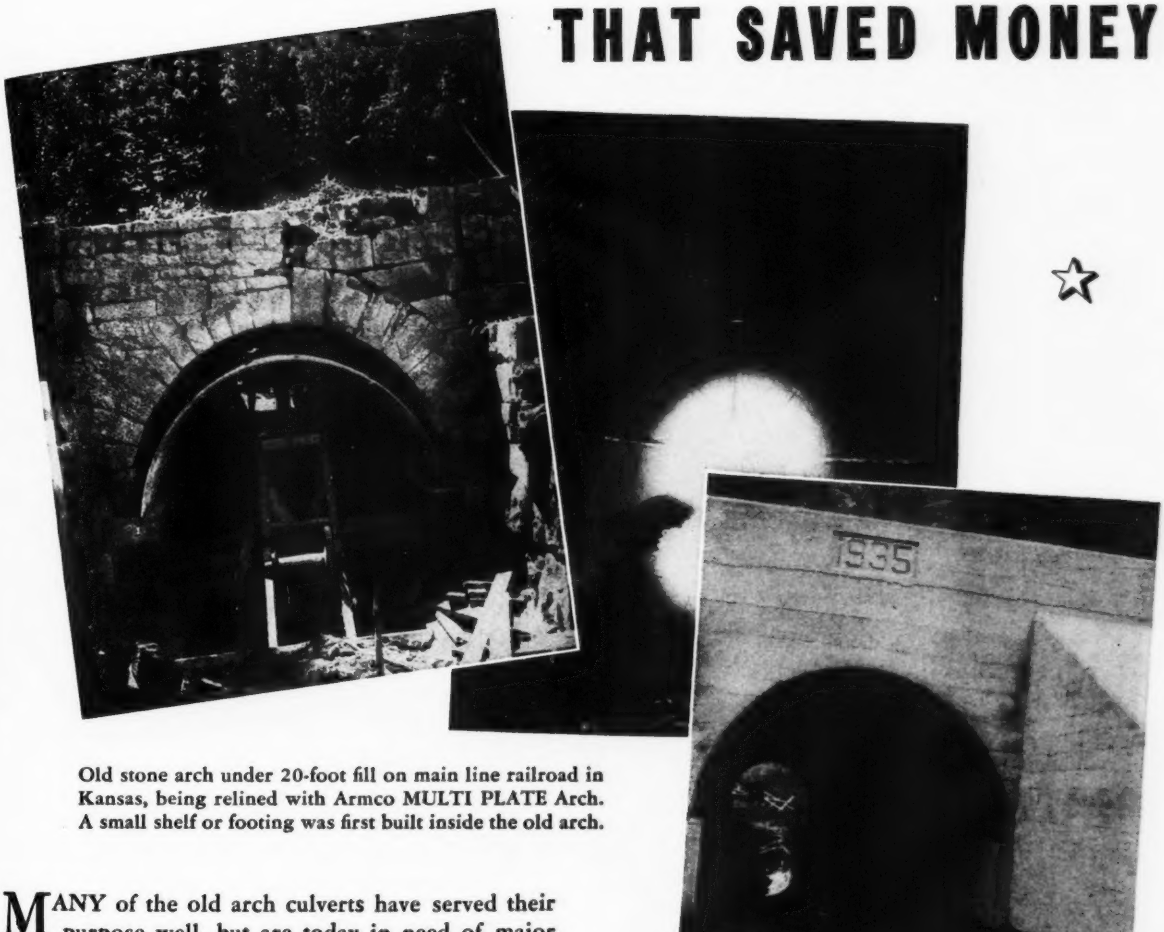
Another Relining Job

THAT SAVED MONEY



Old stone arch under 20-foot fill on main line railroad in Kansas, being relined with Armco MULTI PLATE Arch. A small shelf or footing was first built inside the old arch.

MANY of the old arch culverts have served their purpose well, but are today in need of major repairs or replacement.

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Railway
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November, 1936

Railway Engineering and Maintenance

Wall Street

Does It Own the Railways?

WHO owns the railways? This is a question which arises frequently. It is a question that every railway employee should be prepared to answer.

Many times this question originates among persons friendly to the railways who desire to be correctly informed. Not infrequently it is raised by critics of the roads who portray them as giant octopuses owned by that indefinite ogre known as Wall street, and who use this specter to create a sentiment among the public antagonistic to the roads. Regardless of the motive, it is to the interest of the railways that the facts regarding their ownership be made known. What are these facts?

The Investment

The railways of the United States, other than terminal and switching companies, represent an investment of approximately $26,000,000,000 for rights of way, tracks, structures, cars and locomotives and the myriad other facilities that go to make up a modern transportation system. Against this expenditure there were outstanding in the hands of the public in 1935 securities totaling $18,831,000,000. It is to be noted in passing that this total capitalization is 25 per cent less than the investment in these properties, constituting an effective answer to the oft-repeated charge that the railways contain much "watered" stock. The more than seven billion dollars of investment not now covered by securities afford a measure of the extent to which earnings rightfully belonging to stockholders have been plowed back into the properties either in financing needed improvements or in retiring outstanding obligations.

Ownership

Of the $18,831,000,000 total capitalization of the railways of the United States, $7,174,773,595 is represented by capital stock, while $11,656,138,729 consists of bonds and other forms of funded debt. Who own these various classes of railway securities?

In the development of the answer this question, the first fact to be noted is that, contrary to the impression sometimes held, railway stock is widely distributed and the average holding is relatively small. For generations the stocks of railroads have comprised a liberal proportion of the investments of many persons. Into them they have put their hard-earned savings. A single railroad, the Pennsylvania, had 227,251 separate stockholders on December 31, 1935, whose average holdings were 57.9 shares. The stocks of other railways are equally widely distributed. For all railways, it is estimated that there are at least a million individual owners of railway stocks today.

Railway bonds have likewise long been regarded as an attractive outlet for savings by individuals and large quantities of securities of this class are held by individual investors. While the records are not as readily available, it is estimated that there are at least a million individual owners of railroad bonds and other forms of indebtedness.

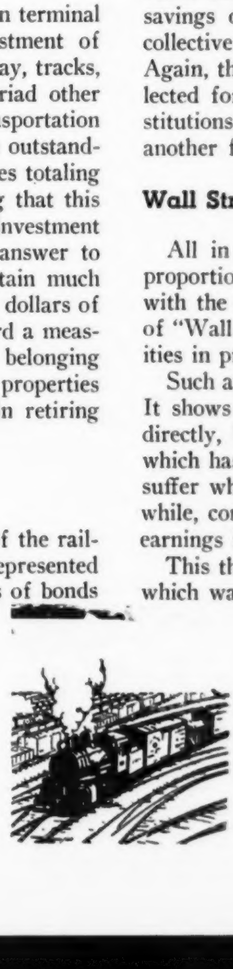
Railroad securities are also held in large quantities by insurance companies, savings banks and fiduciary trusts. Since these organizations are in turn repositories of the savings of the people, their investments comprise the collective savings of a large number of individuals. Again, the large endowment funds which have been collected for the support of charitable and educational institutions include large investments in railroad securities, another form of public holdings.

Wall Street Holdings Small

All in all, these groups account for the very large proportion of railway security owners. As compared with the amounts held by them, the total in the hands of "Wall street" is small and these are principally securities in process of transfer from one owner to another.

Such an analysis constitutes an answer to the alarmist. It shows that the railways are owned, directly and indirectly, by millions of individuals. It is their money which has built and equipped the roads. It is they who suffer when the railways encounter financial difficulties, while, conversely, they prosper when railway traffic and earnings increase.

This the record of railway ownership. It is a record which warrants widespread understanding in order that the attacks of railway critics may fall on deaf ears. t warrants widespread understanding also because of the confidence that such a record will create among the people. It will also establish a sense of partnership with the railways and an interest in their welfare that will greatly stimulate fairer treatment for the roads.



Safe Bridges

A Marked Improvement Has Been Made

NO one can deny that the officer in charge of bridge maintenance is confronted with important responsibilities, or that these responsibilities were materially intensified with the reductions of forces, curtailment of repair programs and extension of supervisory territories that followed the advent of the depression. There is no denying, also, that the cares of the bridge officer have been increased as a result of the stepping up of train speeds. But if recorded facts mean anything, his lot is still much more pleasant than that of his predecessor of a half century ago. We hear much of the opportunities that fell to the lot of the men who took up railroading during the pioneer days, when men were put "on their own" and received rapid promotion if they measured up to their tasks, but there is good reason to believe that the road to advancement was a rough one and that there were many pitfalls on the way. What are the facts?

There are, of course, few bases for comparisons between conditions then and now except as may be inferred from the accounts presented in historical studies, reminiscences of "old timers," and the like, but an exceedingly tangible comparison from one angle is afforded by a study of the accident record. Take, for example, the train accidents ascribed to bridge failures 40, 50 and 60 years ago. In 1876 there were 21, in 1886 there were 19, and the same number were recorded in 1896. "Train was derailed by broken bridge," "train broke through a trestle," "train went into an open draw" were among the entries appearing from month to month. The failure of a 300-ft. truss span in a bridge across the Missouri river in 1879 was ascribed to the derailment of a car in a freight train, but when another span in the same bridge broke under the weight of a train two years later it was decided to replace the entire superstructure. The record of bridge accidents in those days was so alarming as to prompt frequent investigations by public authorities. The historic Ashtabula viaduct disaster in 1876 gave rise to a general investigation of the strength of railway bridges in the state of Ohio, something that no state authority has felt called upon to undertake in a long time.

In contrast with the accident figures cited above, it is of interest to note the corresponding record for the last three years for which classified figures are available, namely, 1932, 1933 and 1934. In those three years the train accidents ascribed to defects in or improper maintenance of bridges, trestles and culverts numbered 4, 3 and 4, respectively, and, together, they resulted in but one death and one personal injury. In other words, there were more accidents at bridges in one month a half century ago than there are now in an entire year, in spite of the greatly increased traffic today. As a matter of fact, it is more than probable that the disparity is even more marked, for while it is certain that the record for recent years is complete, there is good reason for the assumption that accident reports were not filed with the same degree of regularity that prevails today, with the result that the actual number appreciably exceeded the number shown in the record.

There are, of course, many reasons for the greater safety of railway bridges today. The difference between conditions that prevail during a development or pioneer period and those that can be effected by an institution that is thoroughly established is obviously very marked. In the rush to get lines built and trains running, many practices were condoned that would not be countenanced today. Furthermore, the record as to bridge accidents was, in a sense, but a reflection of the accident record as a whole—railroading was commonly looked on as a dangerous pursuit.

Another reason is to be found in the primitive knowledge of bridge engineering, although this can scarcely explain the poor record of 1896 because the principles of bridge design were rather well established by that time. But compared with the present, knowledge of the properties of the materials of construction was not nearly as complete. However, the primary reason for the marked improvement in the safety of railway bridges lies in the perfection of the bridge maintenance organization, the establishment of systematic inspections and the development of rules of good practice for the conduct of routine maintenance. True, the structures for which the bridge maintenance officer is held responsible today are much more substantial and far more reliable than they were a half century ago, but the system under which they are cared for has been so greatly improved that it is only in rare instances that any serious defect escapes attention. This system has been put to a severe test during the last six years and the record shows that it has been possible greatly to curtail both the organization and the expenditures without breaking down its effectiveness as a means for insuring safety of operation. This is surely a testimonial for the men who are responsible for the safety of bridges and for the American Railway Bridge and Building Association which has had an important part in improving the practices of bridge maintenance during the last 46 years.

Soil Mechanics

A New Science in the Making

THERE is no field of engineering in which the factor of safety comes closer to being the "factor of uncertainty" than in that dealing with foundations. This has been true since the beginning of time, as evidenced by the parable of the house built on the sand, and the reason is not difficult to find—foundation material is subject to wide variations and a determination of the exact nature of foundation materials is often difficult and unduly expensive. For this reason decisions concerning the foundation requirements of structures have had to be based largely on judgment and experience, to the exclusion of the mathematical procedures employed in the design of the structure to be supported.

It is only in recent years that any great effort has been made to apply rigid mathematical processes to the study of foundations with the view to the development of a new science which has been designated as soil mechanics. The principles in process of development apply not only to foundations, but also to embankments and excavations, but like all branches of science in which progress has been slow because of the inherent complexity of the

physical facts, soil mechanics is an exceedingly involved subject. In its present stage, therefore, this new science is applicable on a practical basis only to large or extraordinary projects that justify the exacting study necessary. Furthermore, it is apparent that the investigation of the subject must be continued to a point that will permit of the accumulation of a vast amount of experimental data before the principles can be applied generally.

In the meantime, maintenance of way officers must meet the foundation or embankment problems that confront them along much the same lines as they have in the past, ever keeping in mind that the value of their judgment can be no better than the facts that they have developed concerning the condition at the site. It is far better to suffer criticism for spending money in an investigation than to bear the censure that follows a failure.

Highway Crossings

A Medium for Influencing Public Opinion

FEW persons are in the habit of regarding the railway-highway crossing as anything more than just a place where the railway and the highway intersect. But it is infinitely more than that. It is a point where the public comes in brief contact with the railroad and then passes on, sometimes carrying with it a very definite impression concerning the railroad, which may be favorable or otherwise depending on the condition of the crossing.

Highway crossings that present an uneven surface, particularly where there is more than one track, are annoying and disconcerting to the motorist. So is the plank crossing in which protruding spikes endanger pneumatic tires or in which the noise resulting from the movement of vehicles over loose planks contributes to the impression of careless or inadequate upkeep. Hence, when a number of such crossings are encountered during a single trip, the impression made on the mind of the motorist is apt to be a decidedly unfavorable one, and he may even acquire a feeling of resentment against the railroads. On the other hand, those who drive a good deal are apt to experience a sense of real satisfaction, not to say relief, when passing over a crossing that is well maintained and is in good surface. In such instances the impression created is favorable and is certain to redound to the benefit of the railroads.

In a sense, therefore, the highway crossing is a "representative" of the railroads before the public and when it is considered that there are about 240,000 such "representatives" in this country, through which millions of contacts are made with the public daily, the importance of keeping them in such condition that they will make a favorable impression assumes a new significance. One may argue that, since motorists as a whole are not customers of the railroads, any effort or expense incurred in an attempt to influence them favorably is wasted. It must be remembered, however, that practically all patrons of the railways are motorists and that all motorists are at least potential customers of the railroads, and that no reasonable effort to impress them favorably should be spared, particularly at a time such as the present, when the railroads are engaged in an intensive campaign to bring travel back to the rails and, in general, to make the public "railroad conscious."

During the depression, expenditures for the improvement and upkeep of highway crossings were curtailed along with other railway expenses, with the result that many crossings, particularly on unimportant lines and on secondary highways, are not in the best of condition. In view, therefore, of the status of the highway crossing as a "representative" of the railroads, one wonders if the accelerated improvement of such crossings, by means of new installations or the making up of deferred maintenance, does not comprise an important step in the program of the railroads to secure improved public relations.

Forget It

This Is No Time for a "Depression Complex"

"IN these days of limited expenditures we are compelled to cut corners," was the statement made by one speaker at the recent convention of the Roadmasters' Association in explaining his position on the topic then being discussed. Several others voiced similar sentiments. Obviously, there were good reasons for this attitude in 1932 and 1933, but is it justified today?

This is the third year during which expenditures for maintenance of way and structures have been larger than during the previous year. In 1934 the outlay of the Class I railroads was 43 million dollars greater than in 1933, in 1935 it was 27 million more than in 1934, while the expenditures for 1936 will exceed those of 1935 by 60 to 65 million. In other words, some maintenance officers are still thinking and talking in the same terms that they did in the depth of the depression, in spite of the fact that the maintenance operations at the present time involve expenditures at least 40 per cent greater than they were during 1933.

Viewed with a consciousness of what has happened during the last six years there is no doubt that some of the practices prevailing during the nineteen-twenties were influenced by a "prosperity complex." But there is now an equal possibility that judgment may be warped by a "depression complex," leading to the recommendation of palliatives or temporary expedients rather than measures that will produce permanently effective results without resort to extravagance.

The large expenditures being made for new equipment designed to provide better and faster service are proof enough of the confidence of railway managements in the outlook for rail transportation. And there are plenty of examples of smooth-riding track with good rail, well tie plated, and sound ties supported on excellent ballast dressed to neat toe lines to justify the conviction that the incentive for a high standard of roadway maintenance still prevails.

A Gang of 56 Men From One of the Relief Camps Returning From Work On Hand Cars—Note Section of Three-Track Railroad Which Was Completely Overhauled by These Forces

Unemployed Workers Make
on Railway Jobs

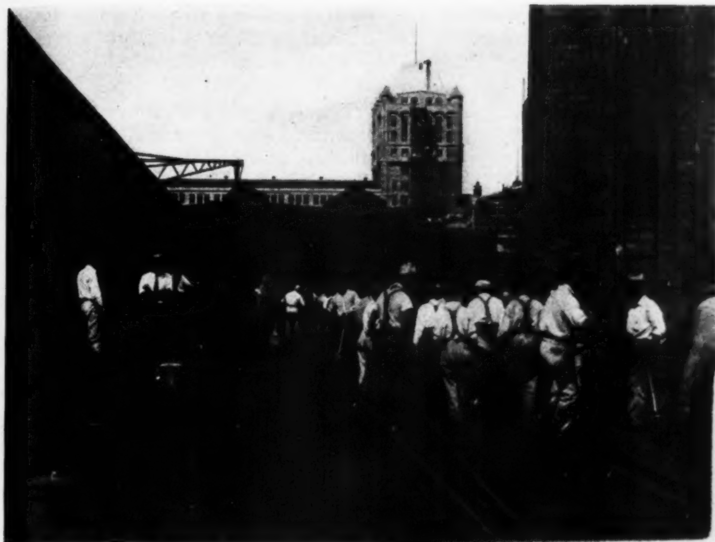
Early this year, the Canadian government closed its unemployment relief camps throughout the Dominion and made arrangements with the Canadian National and the Canadian Pacific railways to employ 10,000 of the men released from the camps in maintenance of way and betterment work at government expense for wages. These men have been working on the two roads since early in May. This article describes not alone the plan under which they have been working, but also the working and living conditions provided and the results that have been accomplished.

SINCE May 1 of this year approximately 10,000 unemployed men taken from Canadian government camps and provincial relief rolls have been employed in track work by the Canadian National and the Canadian Pacific railways, with results mutually satisfactory to the men, the government and the railways. As pointed out briefly in the July issue of *Railway Engineering and Maintenance,* the Canadian government, seeking to close its government-operated relief camps, sought the assistance of the railways in employing the men from the camps in maintenance of way and betterment work, where it was realized that they could work under proper supervision in organizations capable of employing them under good conditions and with adequate equipment. Following negotiations with the railways and the appropriation of the necessary funds by the government, it entered into identical agreements with the two railways under which each road was to give employment in track work to approximately 5,000 men from the camps, or from other sources of unemployed labor if there was an insufficient number of qualified men in the camps, while the government agreed to pay the men thus employed the prevailing wage paid to the regular extra-gang forces of the roads, amounting to not less than 25 cents an hour for ordinary track labor.

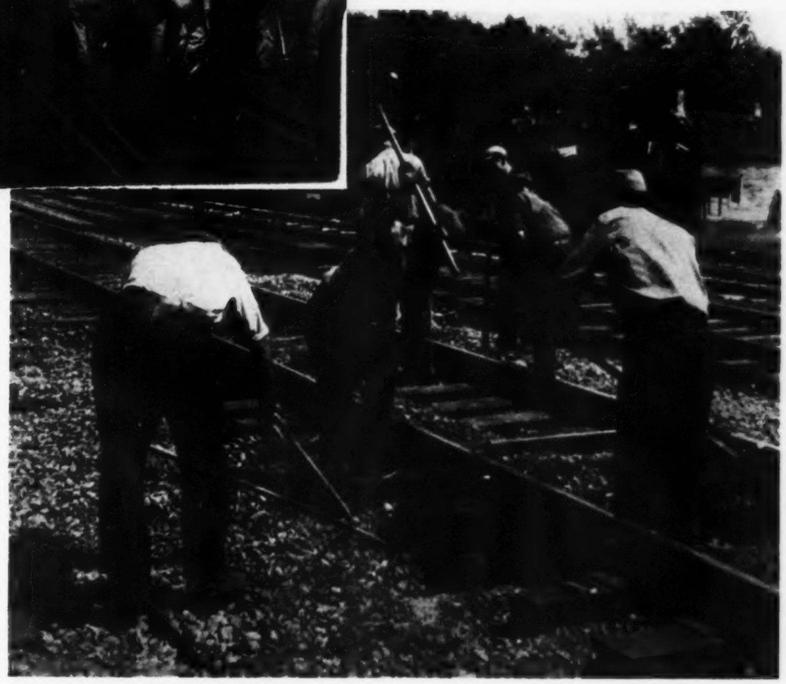
In addition, out of a sum of $1,502,450 which the government set aside to pay the wages of the relief forces on each road, it agreed to reimburse the roads for any amounts which they might be required to pay under any statute for the protection or compensation of the men arising out of injury to or death of any of them, and also for transportation of the men to the railway jobs, if moved from one province to another, or over the lines of both railways. In addition, the government agreed to loan each road, upon request, up to $554,700 to defray other labor expenses which it might have to meet in planning and carrying out the work to be done by the relief forces.

Programs Enlarged

The railways, on the other hand, agreed to enlarge their normal 1936 programs of maintenance of way and betterment work so as to furnish employment for approximately 5,000 men from the camps or relief rolls. They also agreed to bear, at their own



Left—A Gang of 90 Men Screening Ballast Outside the Canadian Pacific's Windsor Station at Montreal. Below—The Relief Forces Soon Became Almost as Proficient as the Regular Extra-Gang Forces



Good in Canada

expense, all costs for supervision, supplies, materials, boarding cars, equipment and train service in connection with the employment of the men. The basic work day was established at eight hours, with pro-rata compensation for all overtime. The railways were permitted under the agreements to make deductions from the pay of the men for board at the prevailing rate for their extra-gang forces, and were allowed to discipline the men or to discharge them for cause in the same manner as their regular employees.

No coercion was used in securing men for employment on the railways, many of the men appreciating the opportunity to re-establish themselves on a regular wage basis, and also the better outlook offered in the railway work. The transfer from the government camps to the railway camps was begun late in April and was practically complete the latter part of June, the men being moved in groups of 100 or less, under supervision, to the specific points where they were to be housed and employed.

The railways were required to take all of the men from the camps who sought employment, regardless of their age and capabilities for maintenance of way work, but were not required to keep any men physically unfit, or otherwise undesirable. With the majority of the men between the ages of 18 and 50, and for the most part in good physical condition, the railways have faced no particular problem in this regard, an attempt being made to find lighter worthwhile tasks for those who could not stand the strain of the heavier maintenance of way operations.

The real problem which confronted the railways in taking on such a large body of men with so little notice was not the programming of constructive work for them to do, or even securing the materials, tools and equipment necessary to their effective employment, which, however, required prompt action and considerable thought, but rather was that of arranging to house the men in suitable camp cars so that they could be kept in gangs and moved about as the work required. As a result of the reduced normal maintenance programs planned originally for the summer, both roads had some available camp equipment on hand, but, confronted with approximately 5,000 additional men each to house, it was necessary for them to arrange for many additional camp cars of the various types.

Provision of Camp Cars

This demand for camp cars was met on both roads largely by hastily converting several hundred coaches, colonist and box cars into cars suitable for camp use, the coaches and colonist cars being used for dining and sleeping cars, respectively, as far as possible, and the box cars for kitchen, commissary, storage and tool cars. Together, the Eastern and Western lines of the Canadian Pacific converted a total of 60 passenger cars, 102 colonist cars and 415 box cars into additional camp cars to accommodate the relief forces, while the three regions of the

Canadian National put in service a total of 840 additional cars, including 36 passenger cars, 40 colonist cars, 590 box cars, 65 vans (cabooses), 25 refrigerator cars, and 84 other type cars for transporting water.

In every respect the camp equipment which housed the relief forces is said by government officials and

Upper Left—A General View Through a Part of the Large 20-Car Camp of the Canadian Pacific at St. Henri, Montreal, Que. Left—One of the Three Dining Cars at the Camp at St. Henri.

railway officers to have been at least as good as the equipment housing the regular summer extra-gang forces of the roads, a fact which has been borne out both by observation and by comments of the men. This condition was brought about largely by the fact that much of the equipment housing the relief workers was newer than the regular extra-gang equipment, and included many passenger train cars converted into sleeping or bunk cars.

There is little difference between the newer camp cars and camp cars commonly used in the United States and Canada, except in the case of the colonist cars, which are a type of sleeping car which was used extensively in past years by both roads in moving groups of colonists into the interior and western provinces. This type of car is built on the principle of the Pullman sleeping cars, usually with 12 upper berths and back-to-back fixed double seats below which can be converted into 8 berths, but without the class and appointments of the Pullman sleeper. The floor space in these cars which would normally provide for two additional lower berths, is occupied by a washstand with three wash basins (not used by the camp forces), but a smoking compartment at one end of the car was used in some cases by the camp force to provide an additional berth. This gave the typical colonist car a sleeping capacity of 21 men, although some of the cars are larger and provided for 4 additional berths.

One of the important features in connection with the camps of the relief forces has been the attempt to keep them sanitary and clean. Steel bunks were employed in all fitted-up coaches and box cars; oilcloth was used on all dining tables; kitchens were kept neat and clean; and all washing and sanitary facilities for the men were kept outside of the cars. Furthermore, each camp had a force of "bull cooks," general clean-up men furnished by either the railways or the boarding contractors, who swept out and straightened up the bunk cars daily, kept the camp sites tidy, attended to general sanitary conditions, and assisted in other ways to promote the general welfare of the camps. Toilets, constructed with the view of adequate ventilation and sanitation, have been cleaned and disinfected daily, and frequently the various cars themselves were sprayed with a disinfectant to insure healthful living conditions and to keep out bugs and other rodents.

Large Camp at St. Henri

The camps have varied in size from a few cars to a considerable number of cars, although an attempt was made as a rule to avoid housing too many men together. Typical of the larger camps was that of the Canadian Pacific at St. Henri station, Montreal, Que., in the western part of the city. This particular camp had a total of 20 camp cars and, at times, housed as many as 150 of the men.

In this camp, which was located in a section of a local freight yard some distance from the main line tracks, the cars occupied four tracks on wide centers, affording ideal conditions for light and ventilation and for the free movement of the men. The cars included 5 colonist cars used as sleepers; 1 passenger coach and 2 box cars used as diners; 4 box cars employed as kitchen, bakery and food storage cars; and 9 box cars employed for a commissary, a tool car, an office, cook's quarters, and for miscellaneous storage space. In all of these latter cars, several men were quartered, bringing the sleeping accommodations of the camp as a whole up to approximately 150 men.

The more typical camps over the railways generally included only two to four cars, and have housed from 20 to 40 men. On the Atlantic region of the Canadian National, for example, the largest gangs included 36 men, there being 21 gangs of this size and 2 with only 23 men.

Contactors Handle Board

Providing table board for the relief forces presented no difficulties to the railways since this problem, for the most part, was turned over to the large, well-equipped boarding contractors which for many years have handled the boarding of extra-gang labor on the Canadian Pacific, and the majority of such labor on the Canadian National. On several of the lines of the Canadian National, the railway operated its own camps, and on certain other lines the camps were run by the men themselves on a co-operative basis, these arrangements being a continuation of practices of the individual lines before their consolidation into the Canadian National system. However, the extent of the railway's part in boarding the men was so limited as to have been of only minor importance.

Regardless of whether the boarding

of the men was handled by one of the boarding companies or by the railways, a stipulated amount for board was deducted from the wages of the men. This is the same arrangement that is employed with the regular extra-gang forces on the roads.

Food Good

In all of the relief labor camps, the men were provided with clean, wholesome food, the table being run "boarding-house" style, with no rationing or limitation of servings like that practiced in the government camps. There has been general commendation for the table fare, with only such minor dissatisfaction as might be found on any large job.

Breakfast at the St. Henri camp of the Canadian Pacific included fresh or stewed fruits, cold cereal, eggs, ham or bacon or sausage, beans and fried potatoes, coffee, tea or milk, and bread. Syrup, honey, jam and marmalade were always on the table. On certain days pancakes were served instead of eggs. Dinner at noon, the men always returning to the camp, was the heavy meal of the day. This included a soup, a hot meat or fish, several kinds of vegetables, bread or muffins, coffee, tea or milk, and dessert of any one of a dozen kinds, including several kinds of pie and cake.

Supper was usually a cold meal, which included a cold meat; fresh salad of potatoes, tomatoes, cabbage, lettuce or cucumbers, or a combination of these; bread or muffins; coffee, tea or milk; and a dessert of both fruit and pastry of some kind. Creamery butter was served at all meals, and there was no limitation upon the amount of food the men might eat.

Few Camp Rules

In order to make life at the camp as agreeable and normal as possible, rules were few and such as there were, were of a character generally relating to sanitation. After working hours the time of the men was their own; they could come and go as they pleased; there was no set hour at which they must return to the camps at night or a specific time for retiring. To arouse the men in the morning there was a general call at 6:30. Breakfast was served at 7:00.

The gang foremen supplied by the railways for the different relief force gangs could, but were not required, to live at the camps with the men. In any event, the cook was usually chief representative of the boarding contractor at a camp and at least nominal head of the camp organization. At the larger camps, a man was usually appointed by the men from among their number to act as liaison between the men, the contractor and the railway, a plan which worked out satisfactorily.

Much Work Done

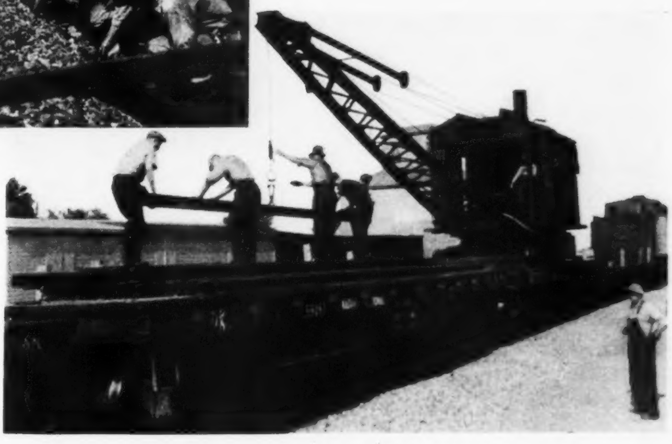
Contrary to the expectation of many government officers and railway men who were admittedly skeptical at first of the plan to employ relief labor on the railways, there has been an unusual degree of satisfaction among the men at the camps and, on the whole, the men not only adapted themselves readily to the work at hand, but accomplished most satisfactory results. As early as the end of July, many miles of effective work on both roads had been accomplished, and, in the words of one higher railway officer, "with an efficiency, in some cases, not exceeded by the regular extra-gang maintenance forces."

The various programs of work carried out by the relief forces, which programs were distinctly separate from those undertaken by the regular maintenance of way extra-gang forces of the roads, included such items as bank and cut widening; ditching; correcting bad drainage conditions within and along the track; ballasting with rock, gravel or cinders; cleaning ballast; surfacing track; dressing the ballast section to a toe line; weeding track; scaling rock cuts; cutting brush; repairing right-of-way fences; and general tidying-up work, especially about stations and terminals.

Work Programmed

The specific classes of work carried out by the different gangs depended largely upon the types of work required in the territories of the different camps. Some gangs undertook a wide variety of work, while others specialized in one or more operations. On the Central and Western lines of both roads, some of the most extensive work done was ballasting. No attempt was made to employ the relief forces in such specialized operations as rail laying, these operations being reserved for the more experienced regular track and extra-gang forces, which were to a large extent relieved of the classes of work carried out by the relief forces.

Typical of the programs of work set up for the relief forces on the various districts of the two railways is that which was established on the Quebec district of the Canadian Pacific, a progress chart of which is reproduced on the following page. This chart shows that the program on this district alone called for 173 miles of rock, gravel and cinder ballasting, 218 miles of sufacing of rock-ballasted track, 8 miles of ballast cleaning, 33 miles of ditching, 163 miles of bank widening, and extensive brush cutting at two locations. It also shows graphically the large percentage of the pro-



Right—Relief Forces Dressing the Ballast Shoulder and Preparing a Toe Line Along Main Line Track. Lower Right — A Relief Gang With a Work Train, Picking Up Rail and Other Track Materials

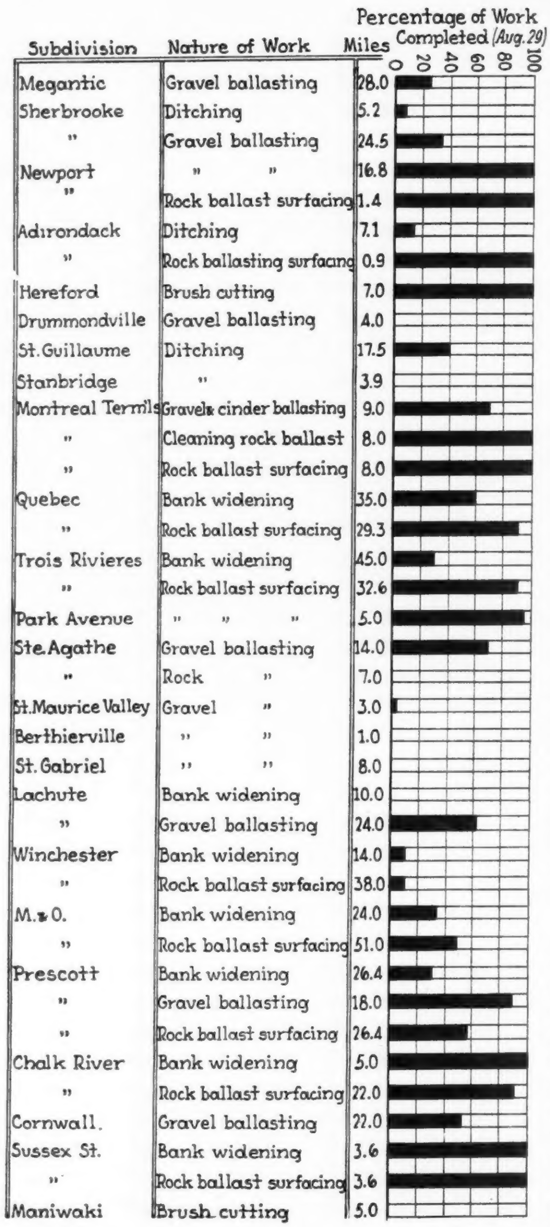


Chart of Work Program of the Relief Forces on the Quebec District of the Canadian Pacific, Showing the Large Amount of Work Completed by August 29

gram which was completed at the end of August, which included approximately 92.5 miles of ballasting, 137.9 miles of surfacing of rock-ballasted track, 8.0 miles of ballast cleaning, 12.3 miles of ditching, and 60.5 miles of bank widening.

In carrying out their work, the relief extra-gang forces were constantly under trained supervision supplied from the regular track forces, and were also provided with qualified equipment operators and maintainers where necessary. Practically all of the operations undertaken were of a character which could be done with hand tools, but a large amount of the heavier work, such as the heavier ditching and bank widening, was done with the aid of power shovels and spreaders, and a considerable amount of the track surfacing was carried out with power tampers. The men were not pushed in their work, and were treated with special consideration during the first week or two while breaking in, but every man was expected to be steady at what he was doing and to produce a good day's work.

In assigning jobs to the various men, their age and physical fitness were taken into consideration, and, as a general rule, if any of the men were partially incapacitated through illness, an attempt was made to find light work for them to do near the camp so they would not lose their pay.

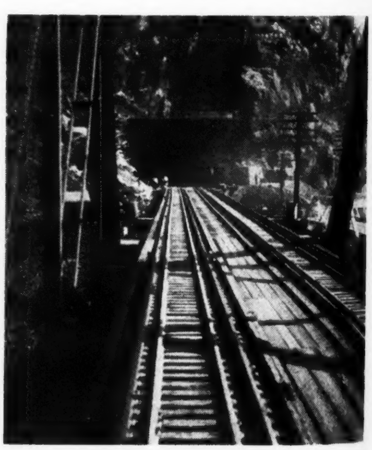
Much of the work of the different gangs was within walking distance from their camps, which were shifted as necessary, but in many cases the men were taken to and from work in worktrains. In still other cases the gangs were equipped with hand cars, both roads having purchased a large number of such cars specifically for the use of these special extra gangs.

In addition to the benefits derived by the railways through the work accomplished by the relief forces, the men benefited through the months of steady employment and the better outlook which this employment gave them, and the government benefited through the relief afforded, at least temporarily, from its unemployment problem. As a matter of fact, the government's benefit has been permanent to some extent, because a number of the men in the railway relief camps resigned during the summer and early fall months to accept steady employment in other lines of endeavor.

Many factors entered into the success of the plan of employing relief forces. These included the close cooperation which existed between the government and the railways; the good working and living conditions provided for the men; the care with which the men were selected for the different gangs and camps to avoid internal dissention and to avoid disturbing local unemployment problems; and the favorable psychological effect upon the men in the camps of being constructively employed, with trained supervision and adequate tools, on a regular wage basis.

Still another factor which had a beneficial effect upon the morale of the men in the camps, and, indirectly, upon the success of the plan in general, was the work of the Frontier college in the various camps. This old institution, through men which it sends out, has been engaged for more than 30 years in bringing opportunity for education, wholesome relaxation and better citizenship to migratory men in many camps of various industries throughout the Dominion.

Approximately 100 young men representing the college were located in the relief camps on the two railways, working alongside the regular camp men daily, and devoting their evenings to instructing the men, in groups or individually, in subjects which would not only be of interest to them, but which would tend to lead them forward into some practical line of study. This work on the part of the college, which was combined with other forms of assistance to the men in an attempt to direct their thinking along constructive lines and to help them become better established, had the enthusiastic endorsement of the Canadian government and the railways, and was widely accepted and appreciated by the men themselves.



Crossing the Potomac at Harpers Ferry on the B. & O.

In this article the author describes practices in manufacturing, laying and maintaining rail that contribute to a greater service life. He also points out certain common misconceptions concerning various manifestations of rail wear or degeneration and discusses other phases of the problem involved in obtaining the maximum service life from rail.

Rail Maintenance— The Roadmasters' Problem*

By C. B. BRONSON

Inspecting Engineer, New York Central System, New York

WE HAVE entered a new era in railroad transportation which has been signalized by three spectacular innovations—streamlining, air-conditioning and shortened schedules—which spell comfort and speed in the movement of passengers and commerce.

But what about the men on the firing line—you and all the faithful section men—whose work and close attention to the finer details of maintenance have helped to make possible the increased speeds and greater comfort? What are some of your problems, both new and old?

We might pause for a few moments to consider what is going on in rail manufacture, and to touch on some points of which you will hear more and more as time goes on. First, let us discuss controlled cooling. What is it and why? The process is simple and involves the placing of groups of 100 rails, initially at 1,000 deg. F., in covered metal boxes, and cooling them to about 300 deg. in roughly 24 hr. Why is this done? To prevent the interior metal of the rail head from being torn apart in a certain range of temperature (around 600 deg.) where brittleness is greatest between the exterior and interior of the head. Extensive research work has shown that when this shattering is avoided the possibility of the development of transverse fissures is remote.

"Normalizing" is another term you will hear much about. Briefly, this process involves the cooling of rails initially to 1,000 deg. F., then running them into a continuous furnace under close temperature control, and reheating to 1,500 deg. F. in 30 min. From this point on the cooling of the rails is identical with present practice. The process is designed to cause grain refinement, to eliminate rolling strains, and to reduce the tendency towards internal shattering. Both of these processes have the same primary purpose—the elimination of fissures. It should be clearly understood, however, that the effectiveness of these methods will be less marked in eradicating the common split and crushed heads, and will have little or no effect on web or bolt-hole failures, or on moon-shaped base breaks.

The hardening of rail ends at the mills is still another development

*Address presented before the convention of the Roadmasters and Maintenance of Way Association on September 16.

that is coming rapidly to the front. While much of this has been done in the field, it is a new departure in mill operation. Various methods are used in different combinations, with the heating being done with producer gas or the electric arc and the quenching by air, water or oil. In some cases the hardening process is applied during the initial cooling of the rails; in others by rapidly heating the cold rail to 1,500 deg. with subsequent quenching, the medium for the latter step depending on the process. Air quenching is being used extensively.

Until the facts have been developed, a cautious attitude should be taken toward rail-end treatment. The heat treatment of high carbon steel is difficult, and wide structural changes may result from fairly small temperature differences. We should be reasonably sure that anticipated benefits from the reduced or slower rate of batter resulting from end hardening are not more than offset by structural and physical difficulties that may arise during the life of the rails in service. In any event, in view of the tendency to the segregation and collection of impurities, especially on the top end of the rail as rolled, it seems questionable whether "A" rails should be subjected to the hardening process.

Mitered Rail Ends

Another process now in commercial development, which looks promising, is the hot mitering of rail ends. The method is unique, first because it has never before been used on hot rails, but principally because only the upper half of the rail is mitered—that is through the head and down to the center of the web. The balance of the rail end is given the standard square cut. The mechanism for doing this is complicated and calls for an exacting set-up, to the end that the two cuts, made separately, will meet or register accurately. The square cut eliminates the possibility of the rail ends running by each other. The top mitered surfaces create, in effect, a continuous line of contact, instead of the gap that is presented by standard sawed rails. More may be heard of this process later.

Of course, many incidental improvements in the manufacture of rails have been made. Steel making is an art and not an exact science, being subject to many variables. Close control of these is striven for constantly. In spite of this, and the taking of all possible precautions, variations in the quality of steel and in its hardness and physical characteristics are bound to occur. Specifications must of necessity recognize these features, and fairly wide limits are therefore permitted for the chemical elements, each of which has a definite function in conveying properties to steel. For instance, carbon is the chief hardening element. Manganese adds much less in hardness but more in toughness and is also to some extent a cleanser. The principal function of silicon is to cleanse and deoxide. Phosphorus and sulphur add little to steel quality, and are more detrimental than they are beneficial.

Classification of Rails

Perhaps many of you have been puzzled by the meaning of the variety of colors that are painted on rail ends, and a word on this subject might not be amiss. Rails with yellow ends are "A" rails. These rails may contain any important impurities or segregation which did not float to the top of the ingot. Knowing this, it behooves us to restrict their service to tangent track, preferably where the train speeds are slow.

The Proper Handling of Rail Is Essential If the Maximum Life Is to Be Secured

Blue usually designates rails which, because of their chemistry, are higher in hardness and therefore are useful for use on curves or where service is severe. The unpainted rails are lower in hardness and, therefore, should go into service where traffic conditions are less severe. In other words each class of steel has a definite value for a specific purpose. This arrangement is far superior to the old method of mixing rails regardless of their chemical character or fitness for service. The inevitable short-length, or green-end, rails result from a variety of mill conditions, such as short crops, the removal of flawed steel near the ends, etc. Brown-end rails are so classed because of internal structural and physical defects, and rightly belong in the same class with "A" rails. Finally there are the white-end rails, or so-called seconds. The latter are not, as many believe, faulty in chemistry, soft, or of lower physical quality, but have minor surface flaws and irregularities. As a matter of good policy their use is restricted to low speed territory, or, frequently, to freight tracks.

In meeting the demands of the traveling public and shippers for high speed operation, how are we going to realize the full value of the many improvements that have been made in rail and other track materials? The answer is by paying close and constant attention to the finer details of installation and to subsequent regular maintenance. Certain methods and precautions to be observed in rail installations are quite obvious and well known, but may be worth mentioning. These include care in unloading—now done mostly by power—to prevent bending. The same principle also applies when old rail is thrown out, because often much of this rail is valuable for relayer purposes and should be kept in as good condition as possible. Care should also be exercised in unloading fixtures.

Well known practices that should be followed during the installation of rail include the adzing of the ties, preferably by machines designed for this purpose, the plugging of the old spike holes and the oiling or greasing of the rail ends in the splice bar area to insure the proper fit and the squaring of the joint bars, and to guard against corrosion. The correct shim thickness between rails for proper expansion is essential. This feature seems to be much abused and needs to be followed with more exactness. The wider the expansion gap, the greater the likelihood of increasing rail end batter. Workmen should be cautioned concerning the damage that may be incurred by nicking the head or flanges of the rail with the spike maul, or by forcing the anchors on the rail in such a manner as to score the rail flanges.

In regard to the adzing of the ties it has been noted that many ties are not receiving a level, even scoring, which may be attributed partly to the fact that they are out of level, or are skewed or twisted because of the manner in which they rest on the old ballast bed. Such conditions result in uneven bearing for the tie plates when the track is finally surfaced.

The squaring of the joint bars, or the provision of a true contact along the fishing zones between the bars and the rail is important. Since this condition is influenced to a considerable extent by the method of tightening bolts it should be given even closer attention now than formerly because of the increasing use of power wrenches. These, however, are very handy tools and will no doubt be very widely used within a relatively short time.

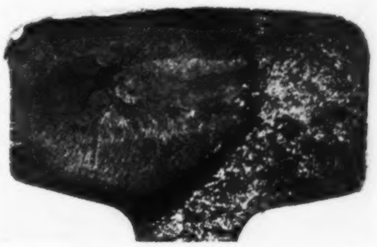
The tie plates should be centered on the ties with the shoulders square with the rail flanges, and those which inadvertently creep under the rail base should be moved to their proper position. Rail anchors should be applied at the end of each day's work. It is also essential that initial swings or kinks in both line and surface should be removed at once, and that low ties, which need to be brought up or shimmed to insure better surface, should be taken care of at the same time in advance of the final careful lining, lifting and surfacing.

End and Gage Corner Flow

The soft decarbonized surface of the rail is susceptible to two conditions under traffic, namely, flow of the surface metal lengthwise into the joint gaps, and a certain amount of inevitable gage corner flow towards the center of the track. The former can be corrected by cross slotting or chamfering the rail ends for which several machines, admirably suited for the purpose, are available for use at a low cost per joint. It is generally desirable to delay the cross slotting for a few weeks or months to permit cold rolling to take place on the bearing surface under wheel load applications. After this initial period further end flow is comparatively negligible.

The amount of the gage corner flow can be controlled by insuring the proper vertical and lateral position of the rail and by providing a uniform gage, which together will prevent, in the initial stages, the lurching, nosing and other motions of power and other equipment on newly-laid rail. A heavy initial corner flow should not be considered as serious or as likely to become accentuated. After the feather edge of the gage corner is flattened or possibly abraded by the wheels, additional gage corner flow will be slight and usually not of any further consequence during the life of the rail.

All the above mentioned points are generally and practically obvious. Then why mention them? Because of one very important point, namely, with improved rail and other materials, the fullest efficiency and longer life that is expected cannot be attained unless the closest attention is given to such details, the subsequent follow up work, and the long period of maintenance that is ahead. It is a forgone conclusion that heavier and improved rail is certain to have a longer life in service. Older ideas and reasons why rails should be removed from service have gone or will go into the discard at least partially.



Maintenance Men Must Watch Constantly for Signs of Rail Failure

We are now definitely in a period where rail of superior quality installed on a small mileage is preferable to a larger mileage of rail of inferior quality. Doubtless our attitude in this respect has been influenced by depression necessities, but we are certain to reap benefits from the more stable and better riding track with a higher life factor that is being obtained.

Obviously, no matter how good the design or quality of the new rail or improved types of fixtures may be, the basic and vital factor is the stability of the roadbed and its ability properly to support the loads that it is called upon to carry. Hence the importance of reconditioning the ballast and roadbed structure concurrently with new rail installations. If this is neglected until later the delay may lead to untold damage to the rail. Past experience has shown that where months or years have elapsed before the necessary and essential spacing of the ties and lining and surfacing of the track have been done, the rail has had to bear the brunt of the burden, with rather disastrous results.

The remark is sometimes heard that a certain piece of rail or track never had proper riding qualities. Was this the fault of the rail? Was it soft and generally inferior in quality, or improperly handled and installed? Or did the trouble arise as a result of the fact that indifferent attention was given to details and to the conditioning of the roadbed? Undoubtedly the fault lies with the latter rather than with the quality of the steel.

So much for new rail. Let us touch on the problem which many of you have of stretching, so to speak, the life of the old rail to the limit of its usefulness. Some of you are in districts where the possibilities of new rail are quite remote. You must either get along with what you now have, or at best you will receive relayer rail from other portions of the line. The policy in this respect is dictated by traffic and financial considerations. Economical methods of preserving such rail are worthy of much study.

It might be well to point out some erroneous ideas, based of course on practical experience, that have been prevalent concerning the reasons for making rail renewals. Such ideas have been mentioned on lines of the lightest as well as the heaviest traffic, and have been used as the basis for formulating opinions as to whether rail is good or bad, whether it needs renewal, or whether it has certain alleged undesirable characteristics.

One phrase frequently heard is that the "rail is crystallized," which is perhaps an adaptation of a notion which has long been harbored by blacksmiths. It may be stated here that there is no such thing as "crystallization" of rails. With the exception of a narrow zone on the rail surface—about 1/16 in. or less in depth—where the metal is cold-rolled by the wheels, the micro-structure of rails does not become altered in the least from the initial mill condition as the result of usage. Careful microscopic examination of rails has shown that the crystals in rail steel do not grow or build up with usage. However, steel may be fractured in such a manner as to give either a fine or a coarse structural appearance. When steel is ruptured suddenly, the crystals apparently have considerable size. When it is pulled apart slowly the fracture may have a finer and more silky appearance.

Another fairly common belief is represented by the statement that the "life is out of the rail," the usage of the phrase being vague. The evident idea is that the physical properties have been exhausted and that the rail no longer has the stamina to carry the loads, or, in other words,

has reached the period of senility. The belief is entirely erroneous. Ample proof is available to show that most of the original physical characteristics of steel, including strength and elastic properties, remain even after years of hard usage. If this were not the case, breakdowns and failures of rails would take place on a large scale. It might also be mentioned that rails rarely if ever fail as girders. Physical weaknesses account for practically all failures. "Shot" or "dozey" are other terms that are used. These are coined words rather than conditions.

Another common expression is that "the ball of the rail is worn out." This illusion has its origin in the formation of an apparent heavy lip on the gage corner, in the flattening of the rail ends, or in other surface irregularities. Careful contours will frequently allay suspicion in this connection. With the exception of the rail on curves, the amount of rail that becomes "worn out" or reaches a condition that is beyond the limit of usefulness is of small consequence. Thousands of tons of rail have been removed in the past primarily because the section was too light for the traffic it was called upon to carry and not because of wear. Practical limits for the reduced thickness of head have not been established because rarely has it been necessary to remove rails for this reason.

A much abused term, which is often used in connection with requests for rail renewals, is "surface-bent." This term has manifold meanings. Rails that are truly surface-bent are those in which the head, and possibly the web and base, have been bent inward and downward under terrific blows delivered by unbalanced drivers or as the result of marked flat spots on wheels. A rail cannot be bent unless the elastic limit is not only reached but exceeded. Minor irregularities, which seem to be in the top surface or are indicated by sighting along the underside of the head, probably describe the general notion concerning surface-bent rail. Such irregularities are ironed out when "sloppy" track is given reasonable attention. While the idea persists, it loses most of its weight when so-called surface-bent rail is removed, for then the surface takes on a different aspect. It is not at all surprising that such rails, when removed and transferred to another territory, are gladly received by the roadmaster as good and suitable rail. Those with eyes trained in sighting the exactness of line and surface of new rails at the mills are not readily deceived by the idea of rails being surface-bent in service in the sense that the term is popularly employed.

The oldest and most common causes given in connection with requests for new rail are that the ends are battered beyond repair and that the rail is dipped or surface-bent at the joint. Final judgment should not be passed on the fitness of the rail until those specializing in such work can render a decision.

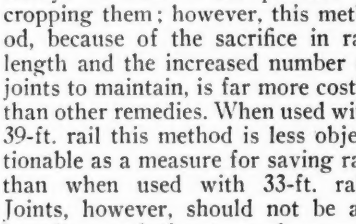
Defective Joints

Various methods are employed for correcting what are known as "shot" joints. These include the use of oversized or crowned bars, new or reformed bars, head shims or other devices, while some roads build up the worn bars. Irregularities are smoothed off with surface grinders and over-running is corrected with cross slotters. Finally there are well known methods of building up the rail-ends by welding if conditions warrant the use of this method. Surprising changes can be wrought in the condition of rails by such inexpensive means. Many cases are known where rails supposedly beyond repair because of end conditions have been reconditioned in such a manner as to render them fit for many years of useful service.

Assuming that rail-end dip and batter are excessive, recourse can always be had to the practice of cropping them; however, this method, because of the sacrifice in rail length and the increased number of joints to maintain, is far more costly than other remedies. When used with 39-ft. rail this method is less objectionable as a measure for saving rail than when used with 33-ft. rail. Joints, however, should not be allowed to reach the stage where such drastic treatment is required. It all reverts back to the question of reasonable care.

Such corrective measures have largely taken the backbone out of the old argument that fifty per cent of the time required to maintain track was spent at the joints. With proper attention to the rail during installation, and with the subsequent use of corrective measures when joints require it, the amount of labor applied at the joints should be proportionately much less than formerly.

Other methods of extending the life of rails may occur to us. For instance it may be found economical to "roll" the rail out of position, machine adz the ties out of face, apply tie plates and reset the rails. Substantial improvement in the riding qualities of the rail and stabilization of the track for a long period of useful and safe service under normal operating speeds can be effected by the application of additional ballast, the insertion of ties where needed, regaging and lining where necessary, careful and uniform tamping after a moderate lift, and the reconditioning of the joints.



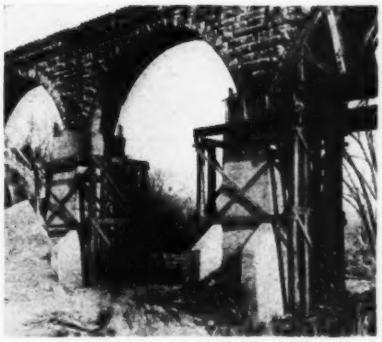
Many other facts might be mentioned but perhaps these will suffice. Let it be stated that not the slightest attempt is made here to discourage efforts to obtain new rail. A policy of conservative economy is now and will be the order of things. Knowing this, the thoughts expressed here are designed to allay fears and to prevent the drawing of erroneous conclusions as to what rail is capable of. The adverse viewpoint that rail is done for must be carefully checked if not discarded. This is said with the utmost sincerity and is based on nearly a quarter of a century of metallurgical studies, along with mill and field observations.

Guarding Against Rail Failure

Still another phase of the problem under discussion is the ever-present necessity of guarding against and watching for signs of rail failure, the common types of which are now generally well known. Education in this direction must continue, for new men are always entering the field and must be taught what to look for. The general and widespread use of detector cars has decreased potential failures by removing defective rails in advance of failure. But the use of the detector car does not relieve the track forces in the slightest degree of the necessity of being constantly on the alert to locate and remove such defective rails as may develop between trips of the test car.

In conclusion the thought is left with you that decided and definite improvement has been, and is still being, made in rail and appurtenances and that your contribution to their increased value is in proportion to the care and attention to details that you exercise during their installation and subsequent maintenance. It is again reiterated that the thoughts that are offered here pertaining to rail now in service are for the sole purpose of correcting erroneous ideas and of assisting in the realization of the maximum possible life of rail.

Bridge and Building Men
Are Concerned With a
Variety of Problems



Bridge Men Discuss Problems at Annual Meeting

American Railway Bridge and Building Association Holds Its Forty-Third Convention at Chicago

THE American Railway Bridge and Building Association held its forty-third annual convention at the Stevens hotel, Chicago, on October 20-22. The meeting was a busy one, the eight committee reports and the three papers included in the program, together with the discussion that ensued as they were presented, occupied all of the time of five sessions, except such time as was necessarily devoted to the opening exercises, the election of officers and other routine business. Supplementing these sessions, there was a luncheon on October 21, at which C. E. Johnston, president of the Kansas City Southern, was the speaker, while on the evening of the same day, the association joined with the Bridge and Building Supply Men's Association in a get-together dinner. Immediately after the close of the convention, at noon on the third day, the members of the association were taken via special train on the Chicago & North Western to the plant of the Johns-Manville Corporation at Asbestos (Waukegan), Ill., where they were afforded an opportunity to observe the manufacture of various building materials and the testing of Transite pipe. About 160 railroad men attended the convention.

Cross-Section of Problems

The program represented a cross-section of the interests and responsibilities of bridge and building maintenance officers, with particular reference to matters of especial import at the present time. Thus, the committee reports covered the Protection of Steel Bridges Against Brine Drippings, the Relative Merits of Different Species of Wood for Timber Bridges, Recent Developments in Pre-framing Timber Bridges, the Maintenance of Railway Roofs, the Inspection and Maintenance of Water Tanks, Adapting Bridge Maintenance Methods to Today's Requirements for High-Speed Trains, Rebuilding the Bridge and Building Organization to Meet the Demands of the Recovery Period, and Underwater Repairs to Piers and Abutments.

Harry R. Duncan, superintendent of timber preservation on the Chicago, Burlington & Quincy, Galesburg, Ill., presented a paper in which he described the damage done to railway buildings by termites, pointing out that their destructive activity is much more prevalent than is commonly appreciated because it is frequently ascribed incorrectly to decay. After describing the various species of termites he told how buildings should be constructed to prevent attack and what should be done when their presence has been discovered. Following the conclusion of his remarks, he presented a motion picture of termites.

R. P. Hart, assistant bridge engineer, Missouri Pacific, St. Louis, Mo., read a paper dealing with the problems that arise in the renewals of the smaller bridges and trestles, with particular reference to the place of the concrete pile trestle with either concrete slab or steel beam spans. He described the three-pile concrete bent developed on his road and showed how this design simplified the driving of the piles.

Discussion of Paints

In a paper on Recent Developments in Paint for Building and Structural Use, F. L. Browne, senior chemist, U. S. Forest Products Laboratory, Madison, Wis., discussed paints from the standpoint of "compatibility," as designating the behavior of one type of paint when applied over an old paint of some other type. He contended that much of the difficulty experienced in getting good results in repainting has resulted from a neglect of this phenomenon. He also compared the properties of various pigments and vehicles when used alone or in combinations, and reviewed some of the recent developments in paint manufacture.

At the opening session greetings were offered on behalf of the American Railway Engineering Association and the Roadmasters and Maintenance of Way Association, the former being represented by its president, A. R. Wilson, engineer of bridges and buildings, Eastern Region, Pennsylvania, Philadelphia, Pa., and the latter by its second vice-president, A. H. Peterson, roadmaster, Chicago, Milwaukee, St. Paul & Pacific, Chicago. T. H. Strate (division engineer, Chicago, Milwaukee, St. Paul & Pacific, Chicago) president of the association, presided.

Election of Officers

In the election of officers First Vice-President E. C. Neville (bridge and building master, C. N. R., Toronto, Ont.), was advanced to the presidency, while C. Miles Burpee (research engineer, D. & H., Albany, N.Y.); F. H. Masters, (assistant chief engineer, E. J. & E., Joliet, Ill.); and C. A. J. Richards, (master carpenter, Penna., Chicago), second, third and fourth vice-presidents, respectively, were each advanced one grade, and W. S. Lacher, managing editor, *Railway Engineering and Maintenance,* was elected fourth vice-president. C. A. Lichty was re-elected secretary-treasurer, while B. R. Meyers, assistant general bridge inspector, C. & N. W., Chicago, George S. Crites, division engineer, B. & O., Punxsutawney, Pa., and R. E. Dove, assistant engineer, C. M. St. P. & P., Chicago, were elected directors to serve two years. Chicago was selected as the convention city for 1937.

The following topics were chosen for study and report at the next convention:

1—Rebuilding our Bridge and Building Organization to Meet the Demands of the Present Day.
2—Recent Developments in the Construction of Timber Trestles.
3—Practical Measures for the Protection of Bridges and Buildings Against Fire.
4—Taking Up the Deferred Maintenance in Painting.
5—Meeting Today's Demands in Water Service.
6—The Maintenance of Moveable Bridge Spans.
7—Protecting Men Against Accident in the Use of Power Equipment and Tools.
8—The Insulation of Railway Buildings.

Abstracts of the addresses and committee reports as well as of the discussions from the floor are presented below. The papers presented by Mr. Duncan, Mr. Browne and Mr. Hart will be published in later issues.

President Strate's Address

IN his address before the convention at the opening session, President Strate reviewed the affairs of the association during the last year and made a plea for a co-ordinated effort to increase the membership, showing by a tabulation of the membership by states and Canadian provinces where the possibilities for gaining new members are the greatest. Turning to the broader aspects of transportation he said that there were matters which should receive greater attention by the members in order that they might impart facts on railroads to others.

Thomas H. Strate
President

Mr. Strate, who has had an extended experience in construction and maintenance on the Chicago, Milwaukee, St. Paul & Pacific, is now division engineer on that road at Chicago.

Statements are frequently made, he declared, that there has been little improvement in recent years in the design and efficiency of railroad locomotives. Such statements indicate striking disregard of developments which, while quite well known to railroad men, are obviously not so well known to the general public. For instance, in the last 18 years there has been an increase of 44 per cent in the tractive power of the average steam locomotive and in the last 15 years there has been an increase of more than 27 per cent in the running speed of freight locomotives. The drawbar horsepower of the 1930 locomotive was 90 per cent greater than that of its 1920 predecessor. The fuel consumption of locomotives per drawbar horsepower hour in 1930 was 40 per cent less than it was 20 years earlier, and fuel consumption per 1,000 gross ton-miles was 22 per cent less. No other industry has shown greater or more continuous improvement than have the railroads through progressive development and refinement of the steam locomotive. These developments resulted in a reduction of $630,000,000 in the railroad fuel bill in a period of twelve years or the equivalent of the annual income at 5 per cent on more than $1,000,000,000.

Trend Is Progressive

The fact that the present standard A.A.R. steel box car, adopted after extended and careful study by a committee of outstanding car engineers, is only four years old illustrates the progressive trends in railroad mechanical fields. Tests are now under way on a new box car that weighs 8,000 lb. less than the present "standard" car and thus what was considered the "last word" when it was

adopted, may give place to a greatly improved type after only a few years.

The same trend applies to passenger equipment, he said. More than 7,000 railroad cars, including 4,000 Pullman cars, are now equipped with air-conditioning apparatus. This tremendous development in the improvement of railroad passenger equipment, involving expenditures of more than $50,000,000 and an incalculable contribution to the comfort of the traveling public, has occurred in the short space of four years.

Loyalty and Leadership

By C. E. Johnston

President, Kansas City Southern

THE American Railway Bridge and Building Association represents an important branch of railway construction and maintenance. As such, it has certain obligations and responsibilities to its members and to the railroad industry in general, which are understood and appreciated by all of us. The interest manifested in the proceedings of the association and the serious consideration given to the subjects scheduled for study and discussion, afford ample proof of the acceptance by your membership of these obligations and responsibilities, and the determination to meet them.

In the short time at my disposal, I would like to direct your attention to a matter on which I hope to be able to offer some constructive thoughts and to make certain recommendations. I have selected as my theme the broad subject of Loyalty and Leadership.

These two factors are essential to continued successful operation. Each is dependent upon the other; the quality of the leadership will be directly reflected in the quality of the loyalty. A loyal employee may be defined as one who bears true allegiance to his employer. Loyalty is reflected directly in efficiency; where loyalty is lacking, efficiency is lacking. I wonder if all of you share my view that there is a real danger today that efficiency may be somewhat on the wane because loyalty is on the wane, and that one of the principal causes of this condition is the fact that there is a tendency on the part of those in responsible charge to overlook the importance of providing means and methods for instilling, cultivating and rewarding loyalty among our supervisory and working forces.

Room for Improvement

Please do not misunderstand me. I know as well as you do that there are thousands of loyal men in railroad service today, particularly among the supervisors and employees with whom you come directly in contact. But my impression is that there is much room for improvement in this respect and that we have, to some extent at least, retrograded and failed to retain the same degree of loyalty and esprit de corps that formerly characterized our railroad personnel.

Since the World War, the trend seems to have been to the left and it continues to drift that way. Each year seems to place the employer further away from the employee, which is not a good sign if efficiency is to prevail. The question is, therefore, whether you are doing everything possible to correct this condition.

The bridge and building department on any railroad, to be 100 per cent efficient, must be made up of "he" men, ready at all times to meet an emergency—repair a washout, rebuild a bridge, assist in clearing a wreck, work long hours night or day, regardless of technicalities in the schedule. I wouldn't trade one pile driver crew of 10 or 12 trained men on our railroad or on any other rail-

Bridge and Building Association

Officers 1935-1936

T. H. Strate, President, division engineer, C.M. St. P. & P., Chicago.

E. C. Neville, First Vice-President, bridge and building master, C.N.R., Toronto, Ont.

C. M. Burpee, Second Vice-President, research engineer, D. & H., Albany, N.Y.

F. H. Masters, Third Vice-President, assistant chief engineer, E. J. & E., Joliet, Ill.

C. A. J. Richards, Fourth Vice-President, master carpenter, Penna., Chicago.

C. A. Lichty, Secretary-Treasurer, Chicago.

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(Terms Expire October, 1936)

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R. P. Luck, assistant engineer, C. & N. W., Chicago.

H. H. Best, master bridges and buildings, T. P. & W., Peoria, Ill.

(Terms Expire October, 1937)

W. R. Roof, bridge engineer, C. G. W., Chicago.

T. P. Soule, general supervisor bridges and buildings, N. Y. C., New York.

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Secretary-Treasurer

road for an extra gang of 40 or 50 men as they are usually made up, when facing a real emergency job of work that requires even a small measure of efficiency. The officers and employees of the bridge and building department of our railroads are not excelled by those in any other department for loyalty and efficiency. The question is—are we to maintain that high honor and continue to occupy a seat in the front row?

There has been a remarkable improvement in the methods employed in performing work but this has largely come about through advancement in machine operation. I doubt sometimes that equal progress has been made in the human element and that leadership has kept abreast. It is not enough that the supervisor shall be well versed in the technical phases of his work. The self-acting mechanical devices have relieved him of considerable of this, but at the same time have multiplied the demands upon him for tact and diplomacy of a high order in maintaining the morale of his men and kindling them with true loyalty.

Destructive Propaganda

Destructive propaganda is the order of the day and workers are subjected to new and dangerous influences. It is true that the disturbing element has always been with us but in earlier days the grievances usually arose with the men themselves concerning wages and working conditions, and when amicable adjustment was made they settled back and could be relied upon to perform satisfactorily.

Today the paid agitator keeps the pot boiling constantly. Strained and unreasonable interpretations of existing rules are advocated actively; minor grievances are magnified and enlarged upon and new fires are constantly breaking out in other places. It is up to us, as leaders, to devise ways and means of overcoming these dangerous doctrines so that the employee may be completely and honestly informed of the facts. This is the call that must be answered; if results are to be obtained, it will be through the thought and purpose of those supervisors who are in a position to inspire confidence. Putting it plainly, the solution is embodied principally in one word—leadership.

I am firmly of the opinion that diminished loyalty can be traced directly to lack of leadership, and by "leadership" I mean constructive thinking along the lines of improved selection and training of men; improved human relations; improved ways and means of affording opportunities to those deserving recognition; improved education along constructive lines; improved methods of combating subversive propaganda; in short, improved supervision from top to bottom.

In the main, our supervision comes from the rank and file. The younger generation of today will be supervisors tomorrow. That is the field we naturally draw from, and rightfully so.

Much depends upon the initial selection of men. Most of us have age limits and certain physical requirements, but do we give sufficient attention to a man's adaptability to the character of work in which he takes employment; his education; his home life; his attitude towards established institutions and his standing in the community in which he resides?

Either before or after a man enters the service, do we provide any means by which he may have the advantages of systematic training along the lines of the work he is to do? Do we leave it entirely to the foreman to select his men and expect him, without assistance, to guide their thoughts into constructive channels and their talents and abilities into efficient usefulness? Do we provide any checkup to prevent inefficient and undesirable floaters from drifting from place to place in our service, thus burdening the payrolls with their presence beyond the period in which their unfitness was first determined? Do we afford any means for combating the destructive propaganda that is constantly being directed at our loyal forces? Do we keep sufficiently in touch with the personal problems of our men, their joys and sorrows, their need for friendly assistance when other avenues are closed, their ambitions, hopes and aims in life?

To many of you these items may appear to be far-fetched, but to me they represent questions, the answers to which spell the difference between leadership and lack of leadership among those upon whom the responsibility for leadership rests; the difference between loyalty and lack of loyalty among the men who are on the "firing line," the men in the rank and file, down "where the wheels go 'round."

For many years I have recognized the necessity for constructive and co-ordinated thought and action along the lines I have suggested. I strongly favor the employment of a personnel officer and assistants whose time is devoted to these and other problems of a like nature. On our own railroad the duties of the personnel organization encompass the entire personnel field, namely, employment, wages and working agreements, safety, group insurance, employees' magazines, personal records, welfare activities—in fact, everything pertaining to the human relations problem. Our progress has been slow, it is true, but there has been progress. More and more attention is being given to the human element on our railroad; greater care is given the selection of men; more thought to their training, their welfare and their future.

An Illustration

As an illustration of our efforts to improve the caliber of men entering the service, we have recently established on a rather small scale a pre-employment training plan whereby high-school graduates, carefully selected, are brought in and given instruction in the rudiments of railroading, and with particular reference to our own property. When they have finished the course, they will be given first consideration for employment at the foot of the ladder. We believe we are on the right track, and expect gradually to expand the plan to include pre-employment training for all classes of service, although at present training for clerical work only is being undertaken.

The executive officers of our railroads need your help in finding a solution for the problem I have tried to place before you. It is not a problem for one man to solve, but is worthy of the best thought that can be brought to bear upon it by all.

Great interest is manifested in the reports made by your various committees. They are widely studied, discussed and made use of. They usually pertain to materials, supplies, methods of performing bridge and building work, and technical matters involved therein. That is all very good. All of it points the way to efficiency and economy.

I recommend to you that this association take steps to consider, actively and seriously, the problem of labor efficiency in all its various ramifications, including those I have pointed out to you today. I further recommend that at least one-third of the time of your business sessions be devoted to the reports of committees on this important subject, and discussion thereof.

I believe the question of pre-employment training is practically unexplored insofar as the railroad industry is concerned, while on the other hand, I am convinced that it affords a field of great opportunity for wise, constructive action in the direction of improving the morale of our forces. This one feature in itself is well worth serious study and con-

sideration on the part of a strong committee of forward looking practical men. It is of great importance, of course, that we keep our feet on the ground in the formulation of recommendations on the subject, and my study of the problem indicates that solution on a common-sense, workable basis is not in the least impossible.

By following the program I have suggested to you, I feel that the American Railway Bridge and Building Association can do the railroad industry of this country a real service, and the association will also have assumed its full share of the responsibility of leadership. We must have this leadership if we are to regain and retain that splendid spirit of loyalty which has, in the past, characterized the bridge and building organizations of our American railroads, and has been so largely responsible for their efficient and economical operation.

Relative Merits of Different Species of Wood for Timber Bridges

Report of Committee

TIMBER is one of the most plentiful and widely distributed natural building materials. Its use by man antedates history. From the beginning, railroads have used timber for bridges. It was expedient for them to do so. In pioneer construction, it was natural that the most available native species of sufficient size were cut and made into timber bridges. This may, or may not, have been proper and economical. California redwood was available to the Central Pacific when it built its main line north of Great Salt Lake in 1872. The original redwood bents and bulkheads were still in place in 1931. Such construction was proper and economical in 1872. If an ample growth of northern black cottonwood had been available along the Humboldt river in Nevada, it probably would have been expedient for the Central Pacific to have used such timber for bridges north of the Great Salt Lake, but such usage would not have been proper or economical, because cottonwood is not a suitable timber for such construction.

Usage and natural causes have determined the relative merits of different species of wood for timber bridges. Wood preservation has increased the number of species that may be used economically, but the depletion of our forests has narrowed the range. The properties required of timber for use in bridges are strength, durability and economy. Price and availability have limited the number of meritorious species to comparatively few.

The relative merits of different species of wood depend on the grade, size, moisture content, specific gravity or density, and on other factors of quality, so that it is impossible to evaluate the merits of one wood against those of another without going into technical details that would be of little value to the man in the field. Obviously, a high grade and particular type of one wood cannot be compared with a low grade and dissimilar type of another. For these and other reasons, this report covers the merits of different species of wood in a very general way.

George S. Crites
Chairman

Piles

For temporary structures supporting tracks while a permanent structure is being built, and for structures where the piles are permanently below the ground-water table, piles may be of ash, beech, chestnut, oak eucalyptus, hickory, elm, walnut, locust, maple, pecan, cypress, Douglas fir, larch, spruce, tamarack, poplar, sycamore, pine, western red cedar, or redwood. This list of species is necessarily a long one, as the use of timber native in the vicinity of the temporary structure or the permanently submerged foundation is usually expedient, proper and economical. Any of these species of untreated timber will be satisfactory for temporary bridges, or for foundations where the piles are permanently submerged, provided the piles are large enough and straight enough.

When green piles are used in the construction of temporary bridges and very hard driving is encountered, the following species, in order, will stand the most punishment without crushing or breaking: locust, eucalyptus, hickory, beech, long-leaf yellow pine, oak, walnut and ash. Green cedar, cypress, chestnut, Douglas fir, larch, spruce and tamarack will stand a reasonable amount of driving, but green poplar mashes and shears easily.

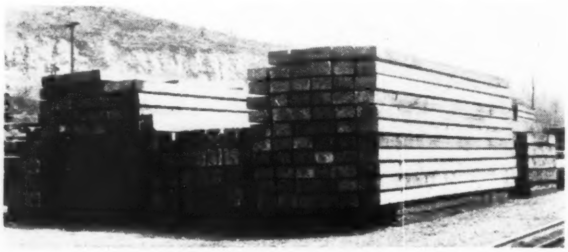
When well seasoned, piles will stand punishment in the following order: eucalyptus, hickory, long-leaf yellow pine, Douglas fir, birch, beech, ash, walnut and oak. Well-seasoned cypress, cedar, gum, chestnut, larch, spruce and tamarack will stand up reasonably well under driving. Seasoned poplar will do for easy driving only. For temporary-bridge piles, the limits of species are restricted only by availability in the sizes required and by price. Native timber usually meets all requirements.

Secondary Bridges

In recent years many unremunerative branch lines have been abandoned and taken up. The trend now appears to be towards further abandonment of poor branch lines. Under consolidations which have been discussed, the release from service of duplicate main or branch lines that are not justified economically may reach into considerable mileage. A timber bridge has to be as secure for one train as it does for many, speeds being the same. This brings up the question of the economical species of wood for piles on secondary lines, or lines that may be abandoned. The use of untreated, serviceable, but less costly piles is expedient for bridges on such lines, if it is known that their abandonment is imminent. The economical species will have to be determined, however, by weighing all factors pertaining to the bridges under consideration.

Generally, locust, eucalyptus, hickory, cedar, redwood, pecan, maple and walnut can be eliminated from consideration. This narrows the choice

to chestnut, cypress, oak, Douglas fir, larch, southern pine, spruce and tamarack. Of these, untreated chestnut, cypress, long-leaf yellow pine, oak, Douglas fir, larch and tamarack will probably be the economical species. Chestnut is available only in restricted areas.



Structural Timbers Must Be of High Quality

Cypress and pine are available in the South. Untreated cypress resists decay much longer than untreated pine. Cypress is not as strong as pine, however, for which reason larger sizes are required for the same strength. Where an indefinite life is to be expected of the structure, the piles should be treated. It may or may not be economical to recover such piling in case the structures are abandoned.

Generally, lack of availability has reduced the species of timber suitable for piles for bridges that may have to be maintained for years, to cedar, redwood, chestnut, cypress, southern pine, oak, Douglas fir, spruce, larch and tamarack. There are records of very long life of untreated piles of redwood, cedar, cypress and long-leaf yellow pine. There are untreated redwood piles now in service that have stood under traffic for more than 60 years. Also, there are records of untreated piles of locust, cypress and dense long-leaf yellow pine, that have been in service for more than a half century. However, these records are exceptional and, generally, all piles for primary bridges should be treated.

Structural Timber

It may be expected that the structural timber in temporary or abandoned secondary bridges will be recovered, so that the economy of using treated or untreated timber will have to be gaged by studies of individual structures. Other than this, the merits of the different species of wood for structural timbers in bridge structures can be discussed as a whole for all bridges.

Timber for sills or mud sills should be sound structural timber with square edges so that there will be uniform bearing. There are records of untreated redwood sills and mud sills in use for more than 60 years, and almost equal service records for locust, cypress, cedar and dense long-leaf yellow pine. Of these species, locust best resists crushing, checking and splitting. Redwood resists decay and checking, works easily, but crushes more readily than the other species. Cypress and cedar resist decay and work well, but crush rather easily. Dense long-leaf yellow pine, generally, makes the best untreated sills and mud sills.

Treated Timber

Preservative treatment, if properly done, does not materially lower the resistance of timber to bending, compression perpendicular to the grain or its hardness. These qualities are desirable in sills. Generally, the economical timber for sills and mud sills will be treated timber. Treated hardwoods, such as oak, hickory, ash, birch, beech, maple and walnut, will suffer less from compression and subsequent shimming than the softer woods. However, all these woods are prone to more or less warping, checking and splitting. Dense short-leaf southern pine makes excellent sills and mud sills when treated. Properly selected dense Douglas fir, when well treated, has proved to be economical in wide areas. Cypress, hemlock and larch do not check or split readily, but they do not resist compression as well as the dense pines or dense Douglas fir.

For posts and timbers in compression, dense southern pine, dense larch, and dense Douglas fir, beech, birch and maple stand up best. The hardwoods withstand about one-third more compression perpendicular to the grain than the soft woods, but this is immaterial so far as posts are concerned. Close-grained redwood stands end compression well, but shears easily with the grain, and is weak against compression perpendicular to the grain. With proper end bearings, redwood makes good posts. Eastern hemlock also shears easily with the grain, as do most hemlocks. Dense larch and red cypress stand up under compression about the same as fir and oak, and are only slightly less resistant to compression perpendicular to the grain than Douglas fir. Generally, dense southern pine and dense Douglas fir make the most satisfactory posts and compression members.

Wood-preserving processes were developed for the use of eastern and southern species. Applying the same methods to Douglas fir did not produce entirely satisfactory results for Douglas fir must be treated almost entirely in heartwood, while treatment of other species is principally in the sapwood. Progress and experience have developed treating processes for Douglas fir, so that satisfactory results are now obtained. One of the outstanding features of Douglas fir is the great size and length of uniform timbers which can be produced. When large and long timbers of uniform strength are required.

Railroads are limited to the varieties of wood that are available in the sizes required, at economical prices. For the greater part, the selection is confined to southern pine and Douglas fir. Southern pine is resilient and takes preservative treatment very well. Short-leaf pine stands compression as well as dense Douglas fir, whereas dense long-leaf pine will stand compression somewhat better than short-leaf pine or Douglas fir.

Caps

Good caps are essential to timber bridge construction. Caps should not warp, check or split, and should resist shock and compression perpendicular to the grain. They should have bending strength, as their bearings may not always be perfect. Hickory meets these requirements, but it is out of the picture economically. Oaks are inclined to check and warp, which makes them undesirable for use as caps.

Considering availability of sizes required and the price that can be paid, railroads are limited largely to the use of southern pine and Douglas fir for caps. Select pine timbers in sizes suitable for caps are becoming scarcer and more expensive; but treated long-leaf pine or treated dense short-leaf pine caps are satisfactory and lasting. Dense Douglas fir will stand shock and compression about 80 per cent as well as dense long-leaf pine, whereas its bending strength is equal to that of dense southern pine.

Stringers

Stringers should be select grade and have strength against bending, resistance against crushing, checking, warping, or splitting, and also be able to resist shock. The hardwoods, generally, resist crushing and may have

proper strength against bending; but they may warp, check or split, and generally may have low resistance to shock. Except in rare cases, soft woods are the proper and economical timber for stringers.

For strength against bending, dense long-leaf pine and dense Douglas fir stand about together, although where longitudinal shear is a factor, the pine outclasses the fir. Dense long-leaf pine resists compression, wear and shock better than Douglas fir. The extreme allowable fiber stress in bending is about 10 per cent more for dense southern pine than it is for dense Douglas fir. This fact was set forth by the National Lumber Manufacturers' Association in its publication on working stresses for structural lumber and timber, issued during 1935. However, select pine timbers in sizes for stringers are becoming scarcer and more expensive and the use of dense select Douglas fir is becoming economical over expanding areas.

In those sections where they are available, cypress and close grained redwood may be used economically for stringers. Neither is as strong as pine or Douglas fir, for which reason larger timbers are required for the same strength against bending. Both shear and crush more readily than either southern pine or Douglas fir.

Dense larch and dense hemlock are about midway between redwood and cypress, and southern pine and Douglas fir, as to qualities desirable in stringers. First choice is dense long-leaf southern pine; second is dense short-leaf southern pine; and third is dense Douglas fir, if the prices are the same. Many different conditions may determine the selection of species, but stringers merit the best timber that is available at reasonable cost.

Trees Such As This Produce Sticks of Any Size Desired

Use Timber Connectors

Probably more timber bridges have failed by reason of faulty bracing than from any other one cause. The usual method of bolting braces to members often develops only 10 or 20 per cent of the available strength of the braces. A suitable gripping device should be used between the braces and the members and then the bolts will only have to hold the braces in place. Unless bracing is short, it should be of structural grades, except for temporary bridges. Any available timber of the right size will serve if properly treated, provided the timbers do not warp, check or split.

Timber for ties should resist crushing and shearing and have strength against bending, especially if their supports are somewhat removed from beneath the rails. They should resist shock. They should not warp, check or split. Hardwoods excel with respect to crushing and shearing and may be satisfactory as to bending, but may be lacking in resistance against shock, and may warp, check or split. Checking and splitting of hardwood bridge ties can be guarded against somewhat by the use of end irons or the application of bolts or iron dowel pins. Straight-grained, properly treated oak ties meet almost all requirements, provided their supports are not too far apart. Birch, beech and ash resist shock and compression, but are apt to check. Bolts and iron dowel pins are used on at least one northeastern road as an aid in preventing checking and splitting in beech and birch bridge ties.

Dense long-leaf pine, when properly treated and protected by tie plates, comes quite close to being ideal for bridge ties. It is resilient and does not break under sudden shock. Usually, ties of this wood hold up well under a derailment. Dense short-leaf pine is somewhat less resistant to compression and it will resist shock and bending only slightly less than the long-leaf variety. It is somewhat more likely to become spongy at bearing areas than dense long-leaf pine.

Dense Douglas fir of well-selected grades is satisfactory for bridge ties, but is less resilient than dense pine. Where bearings are far apart, however, it may be the economical tie, because of its strength against bending. Woods softer than southern pine and Douglas fir are quite unsuited for use as bridge ties.

Flooring for Bridges

Ballast-deck trestles can be classed as permanent structures, for which reason the flooring should be of treated timber. It should be of clear lumber that will not warp, check or split. Well-selected planks of native wood will prove economical if properly treated. Where native wood of proper quality is not available, treated clear southern pine, Douglas fir, cypress, larch or tamarack will make lasting floors. Where treatment against decay is not reasonably available, redwood in the untreated state will last for years. Generally, treated inferior species of wood are satisfactory for ballast deck trestle floors.

The prevalence of rubber tired vehicles on highways now causes floors of overhead highway bridges to fail more rapidly from decay than from wear, contrary to the experience in the past. For this reason, flooring for overhead highway bridges should be treated. However, there may be enough abrasion on such floors to make hardwood economical for flooring, although most hardwoods are subject to a certain amount of warping and checking when exposed to the sun, rain and other weather conditions. Southern pine, Douglas fir, and some of the other woods, when treated and laid with edge grain, give good service when treated. Under very heavy traffic, such laminated floors may be made saw-toothed on top and covered with a good bituminous wearing surface. Such floors are lasting and cheaper grades of wood may be used in them.

Summary

Other than for piling, availability and price have restricted the number of species that may be used economically for bridge work. Oak, beech, birch, dense pines, Douglas fir, larch and hemlock, are more or less available for bridge ties. Dense Douglas fir is the most largely available for structural timbers although in some localities dense pines, larch, cypress, redwood or hemlock might be available and economical. The man in the field prefers treated dense pine or

well-selected treated Douglas fir for structural timbers and treated oak for ties, where tie supports are not too far apart. However, select pine of suitable sizes for structural timbers, and good oak suitable for ties are becoming scarcer and more expensive, so that selected Douglas fir is becoming more and more the timber that will be used for timber bridges. The men in the field should use the denser timbers for caps, sills and blocking, when it is possible for them to make a selection. In all events, these men will have to make the best possible use of the timber that is most economically available.

Committee: G. S. Crites (chairman), division engineer, B. & O., Punxsutawney, Pa.; A. E. Bechtelheimer (vice-chairman), assistant engineer of bridges, C. & N. W., Chicago; H. G. Johnson, instrumentman, C. M. St. P. & P., Ottumwa, Iowa; E. E. R. Tratman, civil engineer, Wheaton, Ill.; C. S. Heritage, bridge engineer, K. C. S., Kansas City, Mo.; J. P. Yates, supervisor bridges and buildings, G. C. L., Kingsville, Tex.; C. D. Black, supervisor bridges and buildings, S. P., San Antonio, Tex.; W. F. Martens, general foreman bridges and buildings, A. T. & S. F., San Bernardino, Cal.; J. P. Wood, supervisor bridges and buildings, P. M., Grand Ledge, Mich.

Discussion

H. I. Benjamin, (S. P.) said that his road had been a large user of Douglas fir for years. In the early days only virgin timber was purchased, but in recent years there has been a trend toward more rigid specifications to insure that the wood would be of the same high quality that had given such excellent service in the past. He also cited some examples of long life of Douglas fir structures. In answer to a question concerning the service of this wood in Southern California, F. A. Armstrong (S. P.) stated that structures built of creosoted and preframed fir will last at least 50 years in that territory. Untreated red wood, he said, will also give long service.

In answer to a comment on the checking of untreated Douglas fir, Chairman Crites said that fir delivered on the Atlantic seaboard by water generally has a high moisture content and that the subsequent drying results in excessive checking. Wood delivered by rail is drier and does not check as much. However, Mr. Crites called attention to the fact that the subject matter of the report deals with treated rather than untreated fir. In answer to an inquiry as to the requirements for the effective treatment of Douglas fir, F. D. Mattos, manager of treating plants, S. P., said that it was not difficult to get effective results in the treatment although the methods differ from those used with other woods; for example, it may be necessary to leave the wood in the retort for 36 hours, a much longer time than is required for most other species. He said that it is his observation that failure in most cases has been the result of using wood that was defective before it was treated. Referring to the comments on checking, he said that any stick of Douglas fir that has pith in it is bound to check.

C. M. Burpee (D. & H.) said that his road has abandoned the dapping of guard timbers because of the difficulty of preframing, and now uses lag screws or bolts that clamp under the stringers. However, as some difficulty has been experienced with the splitting of the ties (red oak), the plan has not yet been adopted as standard. Armstrong Chinn (Alton) reported somewhat similar experience, but stated that, in general, his experience with Douglas fir was favorable.

Adapting Bridge Maintenance Methods to Today's Requirements for High-Speed Train Service

Committee Report

PROBABLY no innovation in railway transportation has ever captured the public imagination or excited such widespread public approval as the introduction of high-speed passenger service. That the desire for faster transportation is not merely a passing fancy, but that these so-called super-speed trains are meeting a real need, is attested by the fact that in every case there has been a consistent and steady increase in patronage from the time they have been placed in service. Furthermore, the favorable reception that has been accorded this faster service is reflected in the insistent demand that the schedules of long-established trains be shortened also.

George E. Boyd
Chairman

This type of service was originally introduced on several western roads in the hope that it might in some measure provide a means of arresting the loss of passenger business to rival forms of transportation. The public response was so immediate and spontaneous, however, that although it is less than three years since the first of these high-speed trains was placed in regular operation, one road after another has announced similar service, and passenger schedules throughout the country have generally been substantially shortened.

New Era in Speed

There are many indications that we are only at the threshold of a new era in speed. While attention has been directed more definitely toward the spectacular performance of passenger trains and the revolutionary changes that are being made in the design of passenger equipment, similar developments have been taking place in the speed of freight trains. The old-time "drag" that was just able to get over the summits of the ruling grades is a thing of the past. In its place we find freight trains running on schedules that only a few years ago were considered fast for passenger trains, and scarcely a day passes without an announcement that earlier freight deliveries are being made at distant terminals.

Although these developments in both passenger and freight service were conceived originally as a means for meeting the increasing competition from other forms of transportation, the natural competition between roads is such as to insure that these higher speeds cannot fail to become practically universal in the near future. Again, as experience is gained, and new developments in equipment and track follow, the logical result will be a still further shortening of the faster schedules and the raising of the average speed of all trains, except perhaps those engaged in local service.

Any reduction in the time between terminals must be met by a corresponding increase in the average speed between these points. Obviously, train operation will be at its best when the maximum and minimum speeds can be kept as near the average as practicable. But in order to do this it becomes necessary to avoid train stops and to eliminate speed restrictions.

Every Minute Counts

Where schedules call for high average speeds, every minute counts. Any reduction in speed causes a loss of time which must be made up by speeds that are not only correspondingly higher than the average, but for a much greater distance. In order to determine the value of unrestricted track in this new field of higher speeds, the Pennsylvania made a series of tests in connection with the inauguration of its high-speed, electrified service between New York and Washington which were described and the results reviewed by Robert Faries, assistant chief engineer—maintenance, in a paper which he presented before the Western Railway Club, in March, 1936.

In making these tests, a 30-mile restriction was placed on ½ mile of track at various places to obtain different combinations of grade conditions. On level grade, if the reduction was from 75 miles an hour, it required 3.14 miles before full speed was again attained. From 90 miles an hour this distance was increased to 6.14 miles. When the restriction was on an ascending grade of 0.4 per cent, these distances were 3.81 miles and 12.12 miles respectively. These data showed that if speed restrictions are to be placed from 5 to 12 miles apart, depending on grades which do not exceed 0.4 per cent, there will be no advantage in raising the maximum speed.

It should be borne in mind in this connection that not a few of the roads which are now operating passenger trains at high speed have grades considerably in excess of those over which these tests were made. Obviously, the effect of speed restrictions on these heavier grades will be much less favorable than on those which have been cited. As a matter of fact, the loss of time occasioned by a reduction in speed from 90 miles an hour to 10 miles over a bridge, say only 50 ft. long, may be so great that under unfavorable conditions it cannot be regained in less than 40 to 50 miles.

Mr. Faries also states that from a standing start on level track, it required 6 min. and 6.5 miles to attain a speed of 90 miles an hour with an electric locomotive geared for 90 miles an hour. In contrast, under the same conditions, it required 22.5 min. and 31 miles to attain a speed of 100 miles an hour. These facts, which supplement the data obtained in connection with the restricted track tests, show quite clearly what other roads have found in actual operation, that as the maximum speed is increased the disadvantages of speed restrictions increase also but to a greater degree.


The Alton's Abraham Lincoln

In what ways do these high-speed trains affect bridge maintenance and in what way does bridge maintenance affect the operation of high-speed trains? We must be able to answer both of these questions before we are in position to adapt our methods of maintaining bridges to the requirements for high-speed passenger service. The operation of high-speed trains, that is, trains having schedules that require sustained speeds of 80 to 100 miles an hour for considerable distances, is of such recent origin that the bridge maintenance forces have as yet had little opportunity to study the subject in all of its phases or develop a technic of bridge maintenance adapted to the new conditions which are being presented.

Even on those roads upon which high-speed trains have been in operation the longest, practices are still largely in the development stage and have not, therefore, by any means become standardized. On the other hand, certain fundamental requirements are common to all roads offering high-speed passenger service and to all structures on these roads. Again as experience is gained, certain facts are beginning to emerge. It will be of advantage to consider them.

Obviously, safety must be paramount. This is a fundamental requirement regardless of speed, but because of the many variations in bridges with respect to both type and details of design as well as of the wide range of conditions surrounding these structures, rules cannot be laid down categorically which will apply to all. Every structure presents an individual problem with respect to safety, which should be interpreted to include both the safe passage of trains and the elimination of hazard to the bridgemen engaged on the maintenance work, which must be worked out specifically for that structure.

Must Ride Smoothly

One of the essentials for high-speed service is smooth-riding track. Track which is satisfactory for ordinary speeds may be entirely inadequate from the standpoint of comfort at high speed. Only a small irregularity in line, surface, gage or level which would be scarcely noticed at ordinary speeds may cause marked discomfort when the speed reaches 90 to 100 miles an hour. For these reasons it has been found necessary to make more frequent inspection of all structures to insure that line and surface are being maintained to the highest practicable standard.

Furthermore, it is the general experience that the passage of trains at high speed is more destructive to structures than at ordinary speeds. This is particularly noticeable where the schedules of freight trains have been shortened considerably and where standard equipment is used in the high-speed passenger service. While the effect of the newer lightweight passenger trains when running at speeds of from 80 to 100 miles an hour is plainly apparent in this respect, experience has shown rather definitely that the vibration

resulting from the increased speed, coupled with the heavier loading imposed upon the structures by the freight trains and standard passenger equipment, creates greater damage and less time is required for it to develop.

For these reasons, steel bridges having open decks, including through girders and truss spans, require more frequent and closer inspection to determine whether structural defects are present or are showing signs of development. Experience has shown that as a result of the vibrations set up by the higher speeds, and this includes both freight and passenger trains, the floor system develops cracks in connections and loose rivets, while cracked pedestals are not uncommon.

It should be borne in mind that the foregoing does not refer to weak structures which are at or near the limit of their load-carrying capacity, but to structures that have ample reserve capacity for the loading to which they are being subjected and which, up to the time the faster schedules became effective, were giving no trouble. It should also be understood definitely that the structural integrity of these bridges is not in question. On the other hand, it is apparent that certain details of design must be modified or new materials used to meet the new conditions which are being imposed by the higher speeds.

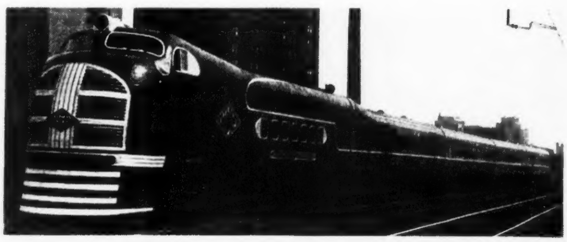
Loose Rivets

Likewise laterals and cross-brace connections are prone to develop loose rivets, where they formerly gave no trouble of this character. Where wooden shims are used under the ties, they show a decided tendency to work loose and to fail much earlier than has heretofore been considered normal.

Wooden trestles present a similar problem with respect to line and surface, since both must be maintained to a higher degree of refinement than was formerly considered to be justified. For this reason trestles must be lined and the track surfaced more often. Chord and brace bolts must be tightened at shorter intervals, while in some cases it has been deemed advisable to increase the amount of sway bracing and to add tower and longitudinal braces on structures where they were not needed formerly.

Track approaches to bridges must be given close and frequent attention. If the track is out of surface at or near the end of the bridge it will cause the locomotives and cars to roll. When they reach the bridge, with its greater rigidity of support for the track, they straighten up, but in doing so throw additional stresses in the bridge members and cause the track on the bridge to become out of line and sometimes out of surface. While the maintenance of the track off of the bridge is primarily a responsibility of the track forces, for the reasons given the bridge forces have a definite interest in seeing that it is done properly. If the track and bridge are maintained to proper line and surface, there will be no indications, so far as smooth riding is concerned, of the change from roadbed to bridge and vice versa.

As yet, the experience of those roads which are maintaining high-speed passenger service has not indicated the need for any fundamental changes in either the methods for maintaining bridges or the organization through which this is done. In this respect the situation does not differ from that of the track forces, which have learned that while no fundamental changes are required in organization or methods, certain adjustments may be necessary in organization and certain refinements in methods must be developed.



The Illinois Central's Green Diamond

Need Alert Foremen

Among others giving information on this phase of the subject, one road reported that "a high degree of responsibility rests upon the foreman of a bridge maintenance gang in high-speed territory, for which reason men in this position cannot be allowed to be of the mediocre type. It has already been found necessary to train younger men especially for these jobs. The older men have developed fixed viewpoints relative to methods of doing work and, in general, we find that they are incapable of adjusting themselves to the new conditions which have arisen in connection with the operation of high-speed trains.

"It is natural that the older workmen do not desire to stay in the gangs assigned to the lines over which the high-speed trains are operated, and many of them have transferred, or expressed a desire to transfer, to lines where the demands upon them are more in accord with their training and experience. This is helpful to the extent that the individual members of the gangs as now constituted, are more alert mentally and more active physically, that is, quicker in both reaction and movement, and to this degree the potential safety hazard is reduced.

"Despite their slower movements and fixed habits, however, the transfer of these older experienced men is a distinct loss which cannot be made up entirely by the younger men of more ready adaptability to new conditions, but less experience. For this reason, we find that we must select foremen for these gangs with unusual care. They must be outstanding in their ability to handle men as well as to direct work; they must be able to think quickly and clearly under all conditions, particularly in emergencies; they must display good judgment and be able to make quick decisions in the face of difficulties; and they must be skilled in the class of work they are to do."

Preparing the Schedule

The programming of bridge work assumes a new importance on lines where high-speed trains are being operated. Preparation for maintenance should begin with the annual inspection, since the recommendations that are formulated should be such as can be followed consistently by the maintenance forces when they arrive on the job.

Equal care should be exercised in preparing the schedule to insure that the allocation of the work with respect to time is done correctly. For example, excavation for bulkheads, the raising of approaches, the placement of concrete and other kindred jobs should be scheduled for the season of open weather. On the other hand, many classes of work can be done as well at other seasons when it is not practicable to do those that have been mentioned, without involving unreasonable cost. Again, certain classes of work should be scheduled for periods of light traffic rather than during periods when business is at its peak, to minimize potential interference with traffic and

the probable high cost of doing the work under such conditions.

Data for preframing and preboring all ties and other timbers should be obtained to eliminate the necessity for field framing and boring. This in itself will save much of the time of the gang using the material as well as eliminate the abuse of the timber through field framing. It will also reduce the cost of the work and shorten the time that the structure is undergoing repairs.

Work Equipment Helpful

Power machines and tools should be used on every class of work where they can be employed to advantage. In many instances they are capable of performing tasks which cannot be done by hand; in other cases they will do the work better than it can be done by hand; while almost invariably, if they are adapted for the work, their use will reduce costs and shorten the time required to complete the job. As an example of the savings that can sometimes be effected through the use of such equipment, there are several five-ton, portable three-speed winches on the market that have records of having saved more than their original cost every month they have been used on certain classes of work.

For these reasons a comprehensive study should be made of every job, to determine how the work should be done and what equipment will be best suited for doing it. In this connection, some maintenance officers are giving considerable thought to the use of off-track equipment for many classes of bridge maintenance, where machines suitable for the work are available, on lines having high-speed schedules or high density of traffic. The plans should include the specific equipment to be assigned, the methods of using it, the dates of starting and completion and the locations for off-track or stationary units. Where compressors, generators or other heavy portable or semi-portable units are to be set up, skids for quick unloading should be provided.

Must Not Slow Down Trains

Since high-speed service shortens the time between terminals to such an extent that it calls for sustained high speed, slow orders can no longer be tolerated. For this reason, the plan should provide for doing the work in such a way that trains will be able to pass over the structure without speed restrictions.

In numerous instances, for example the removal of ties on an open deck steel bridge or timber trestle, the work cannot be done without obstructing the track. In this event it should invariably be done under flag protection. The ties can be preframed at the treating plant or, if they are to be used untreated, in a yard where a crane is available for handling them. They should be numbered consecutively as they go on the deck, so that in applying them there will be no confusion due to misplaced ties. They should then be loaded and unloaded in the order in which they are to be applied, and the track should not be opened until a check has been made to insure that they are in the proper order.

Be Ready

When the time for the actual operation of renewal arrives, every preparation should be completed so that there will be no false moves to cause delay. Provision should be made for direct communication with the dispatcher to insure that the work will be fully co-ordinated with train movements. Then as many ties as can be replaced in the time available should be removed, the new ties substituted and spiked, and the flagman called in.

If the new ties are deeper than the old ones, two courses are open. Some roads prefer to insert temporary shims of the proper thickness between the old ties and the stringers before the actual renewal is started, for the purpose of bringing the base of rail to the elevation of the top of the new ties. Others use long tapered shims, which are moved ahead from time to time as the work progresses, to provide a run off from the new to the old ties. In either event, however, the remainder of the operation is carried out in the same manner as if the old and new ties were of the same depth.

Where relatively short steel spans are to be replaced, this can often be done without the necessity for placing slow orders or otherwise interfering with traffic by the simple expedient of erecting the new span on falsework alongside the old structure and pulling or jacking it into position after the existing span has been removed in the same manner. Obviously, this is feasible only where sufficient time is available between trains, but the same is true of many other phases of bridge maintenance, and experience has shown that the time required to make the shift is surprisingly short, provided proper advance preparation has been made.

In those cases where sufficient time to make this shift is not available, the only recourse is to provide falsework and remove the old structure and erect the new one member by member. Many types of repairs, such as renewing floor beams or stringers, replacing failed connecting members or loose rivets, etc., can be done without the use of falsework or resort to slow orders, provided the intervals between trains are of sufficient length.

Make Falsework Strong

In those cases where falsework becomes necessary, and this includes new as well as repair work, it must be designed to admit the passage of trains at full speed for an indefinite period, rather than as a temporary structure over which speed must be restricted. This means that the structure must be stronger, better braced and of better material. Details must be strengthened; for example brace timbers must be bolted in place rather than spiked on as is now common practice. More time must be given over to inspection and maintenance, especially to lining and surfacing and to tightening bolts.

With minor modifications, the foregoing also applies to cases where abutments or piers require replacement or reinforcement, as well as to the renewal of culverts where the excavation must extend to the elevation of the roadbed. Obviously, in the case of a pipe culvert, if conditions will permit, it should be jacked into place to avoid disturbing the track or roadbed. The important point is that whatever the need for falsework, the design and construction should be of such character that it will not be necessary to place speed restrictions over it.

A Pennsylvania Streamline Electric Locomotive

In the renewal and maintenance of both pile and framed timber trestles, not a few roads have followed the practice for years of avoiding slow orders. That this can be done successfully, even on trestles of great height and length, has been demonstrated over and over again. Because this practice involves no departure from methods that have been in vogue for years, it will not be discussed further, except to say that it is as well adapted for lines operating high-speed trains as for lines operating trains at ordinary speeds.

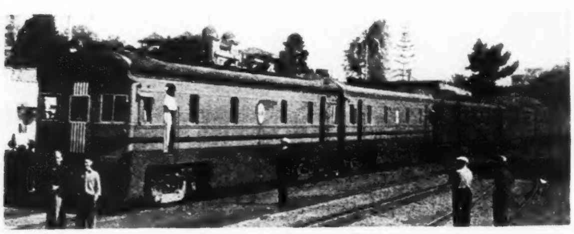
There may be cases where slow orders become necessary, despite all efforts to avoid them. In the event that it is found necessary to restrict the speed over a structure, careful study should be given to the plans for doing the work, (1) to provide for the highest speed allowable under the conditions surrounding the work, and (2) to develop a procedure which will insure that the speed restriction will be in effect for the minimum time.

No matter how skilled the bridge forces may be in the work to which they are assigned, they cannot be successful in their appointed tasks unless they receive full co-operation from other interested departments and are willing to co-operate fully in return. A balky dispatcher or one who has not been given all of the facts with respect to the work under way, can wreck a carefully prepared schedule and plan of work.

Since complete co-ordination of the movement of trains and the work on the bridge is vital to both the transportation and the maintenance departments, close contact should be maintained with the operating officers and particularly with the dispatcher. The use of the portable telephone to provide direct communication with the dispatcher will enable the foreman to plan his work to best advantage or to alter his plan to meet unforseen conditions. It will also enable the dispatcher to keep himself informed of conditions at the bridge site. In many cases, by means of this provision for maintaining direct and constant contact with the foreman in charge of the work, the dispatcher is able to give him information that will enable him to increase materially the productive time of the gang. At the same time, the likelihood of delays to traffic at the site of the work can be almost completely eliminated.

These are not matters that can be made a matter of mutual agreement between the foreman and the dispatcher. To reach such an agreement and arrange for the details requires friendly co-operation between the division engineer, the superintendent, the trainmaster, the dispatcher, the roadmaster, the supervisor of bridges and buildings and the gang foreman; in short, between all of the officers whose interests are in any way affected by the project.

Not infrequently, through such co-operation, it will be possible to divert traffic from one track of a multiple-track line for a few hours during the slack period of the day. Such action may permit the entire deck of a bridge to be removed and a preframed deck to be installed within the few hours available, which, if done under traffic, might require several days to complete. If one has never tried it, he will be astonished at the amount of work that can be accomplished in the short free periods between trains, provided sufficient preparation has been made in advance and the entire operation has been thought through.



The Santa Fe's Diesel-Powered Super-Chief

The importance of co-operation between all of the officers on the division has been emphasized. We wish to give it added emphasis. The bridge maintenance of the future is not going to rest on the individual efforts of the supervisor and gang foreman. To permit safe and uninterrupted operation of high-speed trains and at the same time keep maintenance on an economical footing, every officer, both general and supervisory, each of course acting within his own sphere, must make it his concern. It is only by the complete elimination of departmental barriers and the co-ordinated interest of the departmental officers that both uninterrupted service and economical maintenance can be obtained at the same time.

So far as this committee can foresee, bridge maintenance under the conditions imposed by high-speed service, whether it be passenger or freight, is not going to be fundamentally different from that of the present. On the other hand, because of the conditions that high-speed operation does impose, the demands on the maintenance forces will be far more exacting than ever before, because delays to highspeed trains can not and will not be tolerated. It follows that the men who cannot adapt themselves to the new conditions must step aside in favor of those who will.

Committee: George E. Boyd (chairman), associate editor, *Railway Engineering and Maintenance,* Chicago; John L. Vogel (vice-chairman), bridge engineer, D. L. & W., Hoboken, N. J.; W. A. Batey, system bridge inspector, U. P., Omaha, Neb.; F. H. Cramer, assistant bridge engineer, C. B. & Q., Chicago; C. E. Horrom, master carpenter, Alton, Bloomington, Ill.; A. J. James, general foreman (retired), A. T. & S. F., Emporia, Kan.; R. W. Johnson, assistant engineer, C. M. St. P. & P., Chicago; W. F. Koehn, bridge and building master, C. P. R., Montreal, Que.; B. M. Whitehouse, general bridge inspector, C. & N. W., Chicago.

Discussion

W. S. Lacher *(Railway Engineering and Maintenance)* questioned the committee's conclusions with respect to the damage done to bridges by high speed trains. Impact effects, he said, have been subject to extensive research which has shown that the impact does not necessarily increase in magnitude with the speed, and while the investigation of impact from electric locomotives is still in progress, there is reason for the assumption that the effects will be less than for steam locomotives. He called attention, also, to the difficulty of isolating the effects produced by one class of service or equipment unless special tests are carried out.

Elmer T. Howson *(Railway Engineering and Maintenance)* declared that the day of speed is here and that the operation of high-speed trains will eventually extend over a much greater mileage than it does today. This being the case, it is up to the men in charge of bridge maintenance to reorganize their forces and revise their methods to meet these new conditions. Armstrong Chinn (Alton) contended that more damage is being done by the high-speed freight trains, in spite of the fact that they do not travel as fast as passenger trains. He questioned whether there was any cause for concern regarding the impact effects of the new higher speed passenger trains on bridges.

Recent Developments in Preframing Timber Bridges

Report of Committee

O. W. Stephens
Chairman

BEFORE discussing recent developments in preframing timber bridges it might be well to review briefly the reasons for framing timber before preservative treatment. Treated material was first used some forty years ago and at that time little thought was given to preframing. This is evident today when replacements or repairs are necessary in old structures which were constructed of treated material. A careful study was made to determine the cause of decay in treated timber and in the majority of cases the decay was traceable to that section of the timber that had been cut after treatment or had been damaged as a result of rough handling. In each case the untreated portion of the lumber was exposed and it was at this point that the decay started. In our methods of handling treated timber, as in other things, we have profited by the mistakes of others.

To obtain information concerning the latest developments in preframing timber bridges, this committee submitted a questionnaire to 40 railroads in various sections of the country. The information contained in this report is based on answers to the questionnaire and on information obtained from articles written by representatives of other roads on this subject.

Plans are Necessary

It is absolutely necessary to have measurements or plans of some description of the structure before the timber can be framed. If the structure comprises a new installation, framing plans can be developed with a small amount of field work, but where all or a portion of a structure is to be renewed, it is necessary that accurate field measurements be secured.

The successful preframing of timbers for trestles requires a high degree of accuracy in obtaining the information on the trestle that is to be completely renewed or renewed partially out-of-face. No one particularly enjoys having pointed out to him another's good qualities. Yet we are of the opinion that an example and a lesson are provided by the steel industry. The shop fabrication of structural steel is similar to the framing and boring of timber. The industry has developed this operation to perfection in that each piece is marked and fits exactly into the place for which it is intended.

To insure the same perfection in the preframing of timber, one railroad which uses preframed treated timber exclusively has developed a set of standard forms for use in obtaining and recording the necessary field measurements. These forms are filled out by the supervisor, master carpenter or bridge inspector. The information given on the forms is compared with the office records and is then transferred to framing diagrams which are prepared in such a manner that the fabricating plant obtains the information in a simple form.

On the form used for ordering prebored stringers the measurements are given in such a manner that, with the correct span measurements from center to center of caps at the outside stringers or at any given distance from the center line of the track, it is possible to determine the proper length of the stringers regardless of the position of the bents in the structure.

It is also possible to show on the form the location where the stringers are butt jointed. Another form is used to indicate the preboring and preframing of stringers. With the use of these two forms it is possible to provide preframing information for treated stringers for spot renewals or for use where all stringers in the trestle are to be renewed.

Another form giving information for the framing of dapped guard rails on steel bridges can be adapted for use in connection with timber trestles and also where the guard rail is of the undapped ribbon type. Where the trestle is made of framed bents, the important measurements needed to preframe one bent or more in the structure are indicated on a form provided for this purpose. To use this form properly and also the form for guard rails, a set of standard plans should be available for the detailing of the framing. Other forms are used in connection with the framing of ties for use on steel bridges. Similar forms could be devised for use in connection with open-deck timber trestles.

Regarding the use of treated piling for trestle bents, the replies to the questionnaire indicate that practically all railroads use this type of bent where it is possible to drive the piles. It is the general opinion that it is impractical to drive piles to exact depths and that, for this reason, it is useless to preframe and prebore treated piles. Nevertheless some valuable developments in the use and treatment of piling for trestles have taken place. A trestle constructed of treated pile bents is considered to be practically permanent, provided it is properly treated and maintained.

One middle-western road which has used preframed treated timber in the construction of pile trestles since 1929, has developed a method for establishing the location of the pile bents, which is described in the following. The panel lengths are measured off accurately along both outside guard timbers of the structure to be renewed, the center line of each bent being indicated with a finely pointed scratch awl and by markers consisting of nails driven in the guard timbers. The piles are then located with a plumb bob and stakes driven to mark their location. The spacing and driving of the pile bents are done so accurately that occasions for changing the framing or for reaming or boring holes in the field have been rare. An eastern road, which had trouble

locating pile bents accurately due to soil conditions, found it necessary to complete the framing of the bents before taking the necessary measurements for the stringers. The latter were then framed and installed at a later date.

Protection of Cut-Offs

One of the factors that we must bear in mind is the necessity of protecting the cut-off portions of piling. It is considered good practice to drive piles, if possible, almost to the cut-off level and to cut off only a small amount. In this way only the broken portion of the pile is removed so that a good end penetration of preservative is retained. As it is not always possible to drive piles to exact depths and to avoid cut-offs at points where the untreated wood is exposed, it is the practice on most railroads to treat the cut-offs. While there may be some difference in the materials used the general principle seems to be common to all roads.

Some differences in opinion have been expressed as to the method of treating the tops of piles which are not covered by the cap. A western road that uses pile bents exclusively has established the strict rule that all piles must be given a square cut, while another road chamfers that portion of the pile that is not covered by the cap.

Frame bents that have been preframed before treatment are used by a large number of roads. Some roads use this type of bent exclusively while others use it at locations where it is impossible to drive piles. In all cases the railroads reported that frame bents can be preframed before treatment and assembled in the structure without the reboring of holes. There are various types of frame bents, which will be described separately.

In rebuilding a pile trestle that was destroyed, the Missouri Pacific constructed a preframed treated trestle, composed of framed bents, on the old pile stubs. The sills of these bents were not prebored for drift bolts to hold the sills to the piles; in place of drift bolts anchor straps were used, which were bolted to the pile stubs, the sills and the posts of the bents. All of these holes, except those in the pile stubs, were prebored before treatment. The same type of construction is used for fastening the caps to the posts in both frame bents and pile bents, although in pile bents the piles must be bored to receive the fastenings of the anchor straps. It is evident that this method has advantages as compared with the use of drift bolts. The use of plasters is not necessary and the labor cost involved in renewing portions of the bent is considerably less where drift bolts do not interfere with the work.

In the case of a pile bent where the top of the pile has been treated, it is not advisable to destroy the protection by inserting a drift bolt through the cap or sill into the pile. Moreover, there is the chance that the prebored holes in the cap and sill will not agree with the spacing of the driven piles. The replies to our questionnaire showed that a few roads do not bore holes for the drift bolts while about 95 per cent of the roads bore holes to prevent splitting of the timbers. In the latter group are a few roads on which the caps and sills are prebored before being subjected to treatment.

Stringers

The type of construction for stringers is practically the same on all railroads for both ballast-deck and open-deck trestles. A few roads butt-joint all stringers on alternate bents in ballast-deck trestles, using drift bolts through the stringers to the caps; the stringers are prebored for the drift bolts. Other roads lap the stringers, with the exception of those on the oustide which are butt-jointed. In this method the stringers are not drifted to the caps. The advantages in this type of construction are that it is not necessary to prebore holes for drift bolts and that differences in the spacing of the bents will not have any effect on the length of the stringer.

The stringer construction on open-deck trestles is practically standardized on all the railroads in that the stringers are two panels long with the joints alternating, each set being prebored for chord bolts. The replies to the questionnaire showed that about 90 per cent of the roads using treated stringers have discontinued the practice of using packer or spacer spools and now assemble the stringers tightly together, the reason being that the purpose of the packer spools was to allow ventilation between the stringers to prevent decay. On the majority of the roads the stringers are fastened to the caps by drift bolts. The railroads which prebore the stringers for these drift bolts are about equal in number to those that bore the holes in the field. The reason for field boring in this instance is the uncertain spacing of the bents.

The Missouri Pacific has developed a method of anchoring the stringers to the caps without using drift bolts. This is accomplished through the use of an angle iron which is attached to the outside stringer by means of the packing bolt and to the cap by two bolts. This method can be used with or without packer spools. Another desirable method of attaching the stringers to the caps is employed on other preframed bridges by the Missouri Pacific. This method does away with packing spools by utilizing channels, which are inserted between the stringers on alternate sides of the caps to serve both as spacers and as anchorage for the stringers, and are bolted to the cap. The chord bolts are inserted through holes drilled in the legs of the channels. Details of these methods are shown in the accompanying drawing.

To secure the chorded stringers from longitudinal movement and to eliminate the use of drift bolts through stringers into caps, the Santa Fe uses a 3-in. by 3/8-in. steel strap bent in the form of a knee brace, one end of which is bolted to the side of the cap and the other to the bottom of the outside stringer of each chord.

Another road has adopted the practice of ordering its stringers a little longer than necessary to allow for any difference in panel lengths. The penetration of the treatment at the ends is great enough so that cutting of the ends to fit bent spacing does not remove all the treated wood. The holes for chord bolts and drift bolts are bored in the field.

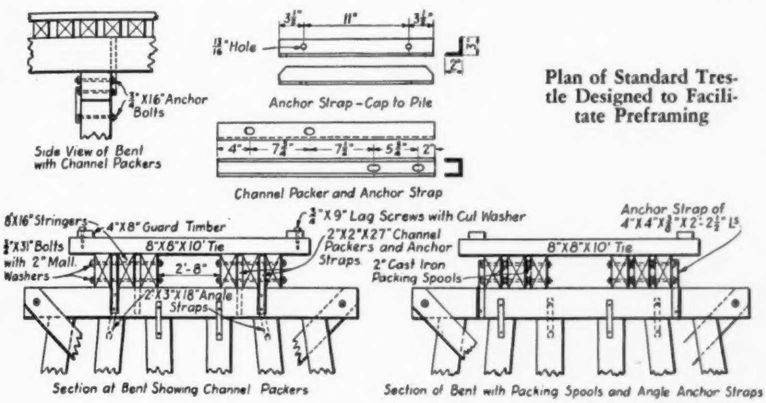
The practice of preframing and preboring longitudinal and sway bracing is increasing rapidly where the bridge is composed of frame bents. About 75 per cent of the railroads that answered the questionnaire are preframing the bracing used with this type of bent. The practice is different with pile bents in that the roads that use this type of construction have found that considerable reboring of holes is necessary. For this reason a majority of the roads are field boring all holes in the bracing used with pile bents and applying a preservative treatment to the holes.

Protecting Field Holes

Creosoted timber had not been in service many years before it was discovered that holes which were bored in the field and untreated formed openings in which decay gained a start in the untreated wood. A number of different methods are being used to protect treat-

ed timber or piling when it is necessary to bore holes in the field. All holes should be well swabbed with hot preservative and a hot application of sealing compound made before the bolts are inserted.

Another method which is finding favor with a large number of roads is the pressure treatment in which the hot preservative is forced into the holes under pressure by means of a "bolt-hole treater," thus causing the preservative to penetrate deeply into the wood surrounding the holes. All bolts are thoroughly cleaned of rust and scale and are dipped in hot sealing compound before being inserted. A few roads apply a heavy coat of coal tar over about two inches of each end of the bolt to seal the holes completely. All holes in timber or piling which have been prebored or bored in the field but are not used should have the ends closed with treated wood plugs that have been dipped in hot sealing compound before being driven. Bolt holes are either the same size as the bolt or 1/16 in. or ⅛ in. larger. Where drift bolts are used a few roads bore oversize holes but the great majority of the roads make the hole the same size as the drift bolt.



Plan of Standard Trestle Designed to Facilitate Preframing

Preframing Ties

The number of railroads using preframed and treated bridge ties is greater by far than the number using preframed and treated timber in trestles. This difference can be accounted for by the fact that every railroad has steel or wooden bridges upon which ties are used while only a portion of the railroads are maintaining and erecting preframed and treated timber trestles. In view of the large number of bridge ties in use it would seem that a standard preframed bridge tie would have been developed. However, our questionnaire brings out the fact that the railroads differ as to the size, framing and boring of the ties.

A number of different methods are used in obtaining the desired data to preframe the ties but, regardless of the method, too much care cannot be used to the end that the ties will fit the steel after they have been framed. If necessary to insure the proper fitting of the ties, the tie framing plan should be triple-checked in the field. To prevent the deck from shifting, it is the universal practice on all railroads to frame ties to fit over the girders or tie stringers on steel bridges. Where cover plates are encountered additional framing is required.

On bridges where cover plate rivets are encountered, the preframing of ties for these rivets is a somewhat doubtful practice. About half of the roads responding to the questionnaire frame the ties to clear the rivet heads, while the other roads allow the ties to seat themselves on the rivet heads. On bridges where the rivet spacing is such that little material remains between the framed rivet grooves for tie bearing it might be good practice not to preframe for the rivets as that portion of the tie between the grooves is not large enough to bear the load and will be crushed, resulting in slack or loose ties.

To protect treated ties from mechanical wear, tie plates are being used by all roads, although practices in regard to the preboring of ties for spikes and tie plate fastenings differ somewhat. About 30 per cent of the roads prebore ties for spikes and tie plate fastenings although the percentage of roads that prebore the ties for use on bridges located on curves is considerably less. A number of roads have learned from experience that prebored ties are not practical for steel bridges because of variations in steel work, which do not allow the ties to fit uniformly, the result being that the relative positions of the ties are not in accordance with the framing plan. In these cases the holes in the ties have to be plugged and new holes bored. To insure a thorough job, these new holes must be treated. In a number of cases bridge men have neglected the plugging of the holes and have bored new holes close to the old ones, resulting in loose spikes or tie plate fastenings.

Another faulty condition that is common on almost every road that uses ties which have been prebored for rail and tie plate fastenings arises out of the neglect of the track or bridge foreman to see that the tie plates are placed correctly so that the holes match for spiking and that the plates are not shifted. Once the rail has been spiked it is very hard to determine if the track has been shifted.

Effect of Traffic Conditions

Traffic conditions which the bridge men have to contend with when renewing ties has an important bearing on the quality of the work, and should be considered in the preframing and preboring of ties. In most cases bridge decks are renewed under traffic and it is possible to place only a panel or two between trains. In such cases the rail is spiked into position with little regard to the prebored spike holes. In other cases the line of drilling on the new ties does not match the line of spike holes in the old and worn ties which are being removed.

In the case of open-deck timber trestles, our questionnaire brought out the fact that a number of roads have installed trestles more than 1,000-ft. long in which all material, including the ties, was prebored and preframed. The structures were erected without the necessity of boring more than a few holes and with practically no reframing of material being required. Since it is the general practice of a majority of the roads not to preframe the ties over the wooden stringers, on open-deck trestles, it is the practice to prebore the ties for this type of structure, thus the ties may be shifted on the stringers to allow the prebored holes to conform with the desired alinement of the track.

The Delaware & Hudson uses the M & L type of tie plate and rail fastening on bridges where heavy rail is used, which eliminates the use of cut spikes or screw spikes. In this construction a tempered spring clamp serves the double purpose of spike and anti-creeper. The

tie plates are securely fastened to the tie by means of a compression screw spike, the holes for which can be field bored and treated without delaying the installation.

Another type of rail fastening is used by the Delaware & Hudson with the lighter rail sections. Through the use of a spring clip with a hook bolt that fits the standard spike hole this device eliminates the use of cut or screw spikes for holding the rail. The tie plates are held in position by compression screw spikes and the holes are field bored and treated.

A number of roads have obtained good results with installations of prebored bridge ties on steel bridges, but the majority of such installations have been on short bridges and on tangent track. Until this year, the Delaware & Hudson prebored all bridge ties for spikes, lag screws and screw spikes, but because of irregularities in the steel, some of the ties would not line up properly. With this new type of fastening, the ties are field bored and treated for the tie plate and guard rail fastenings.

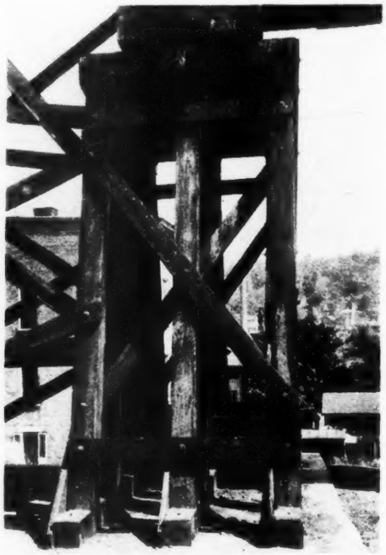
The railroads follow different practices in regard to the preboring of ties for outside wooden guard rails. About 80 per cent of them maintain that better results are obtained if the ties are bored in the field, as this method insures the proper line in relation to the rail. When the bridge is located on a curve, it is evident that each tie would have to be bored differently to allow for curvature of the track. As this would require a large amount of extra detailing on the framing plans the results would not offset the added expense.

Guard Rails

The railroads are about equally divided in regard to the framing of guard rails. Some favor dapping a 6-in. by 8-in. timber over the ties for ½ in. to 1 in., while others use a 5-in. by 8-in. or 4-in. by 8-in. timber that is not dapped over the ties. There seems to be a trend away from the dapping of guard rails on steel bridges because the correct spacing of the ties cannot always be assured; it is sometimes necessary to adze the guard rail. Another objection to the dapping of the guard rail is that the detailing of the framing plans requires extra work on the part of the engineering department. It is seldom that a uniform tie spacing can be used for the entire length of the bridge; thus the guard rail must be detailed for the full length of the structure. Any number of cases have been reported where the dappings on the guard rail have been broken off in shipment or handling. This is true even when each spacer has been securely nailed at the framing plant.

In regard to timber trestles, where a uniform tie spacing can be assured, there are no objections, other than those concerning breakage, to the dapping of the guard timbers. The guard rails are also prebored for the anchoring of the ties.

A number of roads prevent the ties on bridges from bunching together by using "bulldog" tie spacers. The feature of this arrangement is a double-edge saw-tooth steel strip which is placed between the tie and the guard rail. When the guard rail is securely fastened to the tie, this metal strap penetrates both surfaces, preventing any movement of the tie.



The Timbers of This Tower of Framed Bents Were Pre-framed

Those roads which do not prebore the ties make it a practice not to prebore the guard rails for fastening the ties, their reasoning being that because of the uncertain tie spacing it is often necessary to change the location of the holes in the guard rails to conform to the tie spacing.

A large number of roads have obtained good results with prebored and preframed guard rails and prebored ties. These results may depend on the length of the structure, the type of bridge and whether or not any track curvature was involved. In any event these roads are fairly well convinced that it is possible to preframe and prebore ties and guard rails for bridges, which will be correct after application.

Three types of fasteners are in use for securing the undapped guard rail to the tie and for preventing the bunching of the ties. Some roads use a ½-in. by 10-in. or ⅝-in. by 10-in boat spike in each end of each tie. Where these are used a ½-in. or ⅝-in. hole is bored. Other roads have adopted the ¾-in. by 10-in. lag screw or an ordinary bolt and nut with lock washer or lock nut for insertion in each end of each tie or every third tie; in each case the guard rail and tie are field bored and treated. Where each tie is secured, it is the practice of most roads to stagger the holes in the guard rail about the center line to prevent checking and splitting.

Those roads which use the dapped guard rail are using the lag screw or ordinary bolts, lock washer and nut in each end of every fourth tie. A few roads have experienced less movement of ties and breakage of the spacer blocks when boat spikes have been used in the intermediate ties.

On timber trestles boat spikes are used in each end of each tie to anchor the ties to the stringers. Another method is to use a boat spike or drift bolt in every fourth or fifth tie on tangent track and every alternate tie on curved track. A few roads place bolts through the tie and stringer at about the same intervals, using the same bolt, where possible, to secure one end of a strap iron extending from the cap.

In overflow districts the decks are fastened to the bents by means of bolts through the ties, stringers and caps at each bent. Another method involves the fastening of the stringers to the caps by means of lengths of strap iron bolted to the caps and fastened to the stringers at the chord bolts or to the deck anchor bolts.

Some railroads have made considerable more progress in the development and use of treated material than others because the topography of the country which they serve makes the timber trestle more suitable than steel or concrete. These roads have developed the use of preframed material and have trained their employees in the proper handling of this material, with the result that today a structure built of treated material can be considered as permanent as a steel or concrete structure.

In the case of renewals of portions of bridges, the use of dating nails as a means of giving the year of installation of the individual pieces is quite common.

A number of roads have been so

successful in the preframing of all members of trestles, except the piles, that they have prepared standard framing plans for both ballast deck and open deck trestles. The plans for open deck trestles include details of the sills, posts, caps, stringers, tie spacers or guard timbers, bracing, bulkheads, walks, hand-rails and water-barrel platforms. The ballast deck plans include, in addition to the deck plans, details of the ballast timbers, plank and spacing blocks.

Substantial progress has been made in the use of preframed material for bridge structures, but in every installation the material must be handled and erected by bridge carpenters. Only through the proper organization and training of the men can the best results be obtained in the handling of treated material. The life of the structure depends largely on the precautions these men take in handling and applying this material.

Those railroads which have been using preframed material long enough to develop standard plans for its use have also developed rules and regulations for the handling of this material. A few of the more important rules that have been developed on the Atchison, Topeka & Santa Fe are given in the following:

1. The damaging of the surface of treated timber or piles by the unnecessary use of timber hooks, peevies, etc., should be avoided. When possible, treated timber and piling should be handled by rope slings to the final position and not allowed to fall.
2. When it becomes necessary to work from scaffolding in constructing the bridge, such scaffolding should be supported, when practical, in some manner other than by nailing the members to treated timbers and piling.
3. When necessary to disturb the surface of treated timber or piles, or when the surface has been damaged through handling, such surfaces must be mopped with a liberal quantity of hot preservative, followed by two applications of hot sealing compound.

Committee: O. W. Stephens (chairman), bridge and building supervisor, D. & H., Colonie, N.Y.; L. G. Byrd (vice-chairman) bridge and building supervisor, M. P., Poplar Bluff, Mo.; C. M. Burpee, research engineer, D. & H., Albany, N.Y.; J. F. Seiler, engineer, American Wood Preserving Association, Chicago; F. M. Lehrman, bridge draftsman, C. & N. W., Chicago; R. C. Henderson, general foreman, B. & O., Garrett, Ind.; P. P. Lawrence, supervisor bridges and buildings, N.Y.C. & St. L., Tipton, Ind.; J. L. Enright, bridge and building supervisor, St. L. S. W., Tyler, Tex.; V. S. Brokaw, instrumentman, C. M. St. P. & P., Chicago; and R. W. Cook, master carpenter, S. A. L., Atlanta, Ga.

Discussion

J. P. Wood (P.M.) emphasized the desirability of preframing in order to avoid abuse of treated timber in the field and the probability of early decay of the portions that have been cut in the field. W. A. Batey (U.P.) stated that his road has found it possible to frame timber trestles complete, except for piling and brace planks, and substantially all lumber for stock yards and for wood box culverts. All ties are prebored for spikes for the running rail and guard rail for use on both timber trestles and steel bridges. Piling is invariably treated to refusal at the cut off, and by the field pressure method at the bolt holes required for attaching sway bracing. When asked whether trouble has been experienced in the fit of spike holes, Mr. Batey stated that there had been some trouble in the past, but that younger men, with engineering education have been trained to make sketches for preframing and that as they gain experience they are assigned to oversee the framing operation, since which time this trouble has substantially disappeared. In answer to another question, he stated that sketches are made that show all details, including the locations of holes, daps, dimensions and other data.

Under-Water Repairs to Bridge Piers and Abutments

Report of Committee

UNDER-WATER Repairs to Bridge Piers and Abutments require much serious thought and investigation as conditions are seldom the same in any two cases. Structures vary in design, from those of the light single-track type carrying short spans at little elevation above water level, to mammoth monuments of engineering skill reaching upward above the water to great heights and downward an equal or even greater distance through water and strata of dirt and shale to solid rock.

The making of under-water repairs to the latter type of structure, however, does not as a rule cause maintenance men great concern, as structures of this kind were mostly built at a much later date than those in general use on railroads, and, as a result of lessons learned in the past, have been designed and constructed to withstand the agencies of destruction which are responsible for failures in lighter and older structures.

E. C. Neville
Chairman

The structures that are causing the greatest concern to maintenance men in regard to under-water repairs are masonry piers and abutments that were built from 50 to 80 years ago. However, the fact that they have been in constant service for this long period speaks well for the design and workmanship prevailing in the early days of bridge construction and it is safe to assume that, in many cases, failure is due only to the increased loads to which these structures have been subjected.

Concrete structures that were built to the antiquated specifications in vogue in the days prior to the advent of modern and scientific methods of designing and mixing concrete are also a source of great concern. Due to their lack of density they are especially susceptible to scour and erosion which may, in a short space of time after deterioration has commenced, impair the stability of the structure to the point where repairs are impracticable and complete renewal the only remedy. Here again, we are forced to recognize the pru-

dence of frequent under-water inspection with a view to the detection of imperfections that may be remedied at small cost and not allowed to grow into major defects.

Defects of so serious a nature as to cause alarm and require prompt attention may appear unexpectedly and suddenly, or on the other hand may be the result of slowly progressive erosion. But, whatever the nature of the defect, the difficulty and expense of making repairs are increased by procrastination or delay.

Common Defects

Defects most frequently encountered which make under-water repairs necessary include scour around and under the footings of the structure; the washing out of mortar from horizontal joints, allowing the courses of stone to sag; the splitting or crushing of stones directly under the load applied on the bridge seat; and the dislodging of stones by heavy movements of ice.

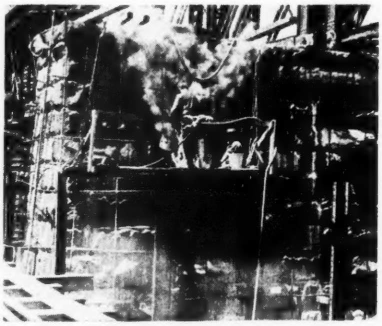
Except in cases where the masonry is supported on a timber foundation or on concrete piles, scouring under a pier or abutment will result in the collapse of the structure if it is not detected and repairs made before it has become too far advanced. In such cases the scouring or undermining of the foundation has been known to reach a depth of several feet so that the masonry is supported only on the piles. Thus the support becomes entirely inadequate and at the best can delay for only a short time the complete failure of the structure, with possibly disastrous results.

The washing out of mortar from the horizontal joints will lead, in a surprisingly short time, to the necessity for heavy repairs, as the sagging of the courses detracts from the stability of the structure and the stones are easily shifted out of position by heavy movements of ice. Split or crushed stones directly under the load-bearing points of the superstructure, which are sometimes found under water, are a menace to the safety of the structure, particularly during the presence of ice jams or drifting ice floes.

Careful Inspection Necessary

Without careful inspection it cannot be readily determined when under-water repairs are necessary, as it is possible that the portion of the structure above the water will give no indication that conditions below are not what they should be. Furthermore, delayed or deferred inspection not infrequently has been responsible for the necessity of making more extensive and costly repairs than would be required in the event of more timely inspection. This happens because, in the early stages of river-bottom scour adjacent to a structure, it is often possible to stop further progress of the scour by carefully placing rip-rap around the point of danger. This, of course, does not apply in all cases because it is difficult to hold even extremely heavy rip-rap in place in swift water carrying heavy ice floes. In such cases, the only safe course to follow is to make permanent repairs as soon as the scouring is discovered.

On a project involving the under-



Repairing a Bridge Pier

water repair of a river pier, which was recently undertaken by one of our larger railroads as a result of the severe settling of the courses of stone at the nose of the pier, it was found that the pier was built on what appeared to be a stone foundation but in reality was but a layer of hard shale. The shale had been worn through by scour, exposing about two feet of boulders and coarse gravel between the underside of the shale and solid rock. The boulders and gravel were being washed away by the swift water so that the bottom courses of stone were allowed to drop out of place, leaving the pier in a precarious condition and susceptible to sudden complete collapse.

Preliminary Work

It was decided to drive a steel sheet-pile cofferdam around the pier about six or eight feet away from the masonry so that repairs could be made after the cofferdam was unwatered. However, owing to the presence of the boulders, the piling could not immediately be put down to solid rock and it was necessary to remove the boulders with a clam-shell bucket operated by a locomotive crane located on the deck of the bridge about 75 ft. above the river bottom.

After this was done a timber frame was built around the pier and securely braced against the masonry, around which the sheet piling was set up. However, as it was impossible to get any penetration with the piles because of the rock bottom, it was necessary to seal the bottom of the cofferdam with bags of concrete. To accomplish this, jute sacks were filled about three-quarters full with dry-mixed concrete; these sacks were then lowered to the bottom on the inside of the cofferdam, where they were handled by a diver. A section consisting of about eight sheet piles was raised by the derrick about two feet off the rock bottom and then lowered and allowed to come to rest on the bags of cement, which the diver had so placed that they overlapped each other. The weight of the pile hammer was allowed to rest on the tops of the piles to force them into the bags of concrete sufficiently to get them thoroughly bedded without breaking the bags. When the bottom had been sealed in this manner the unwatering of the cofferdam was accomplished by two gasoline-driven centrifugal pumps with 12-in. suction pipes, which were set up on the top of the cofferdam.

Naturally the joints of the sheet piling were not tight enough to prevent leaks; therefore, as the level of the water in the cofferdam was lowered and leaks were exposed, bags of cinders were lowered on the outside to a point opposite the leak and then opened. Thus the cinders were spilled against the leaking joint so that the inflow of the water forced them into the joint, stopping the leak. When the water had been lowered about four feet it was held at that level while another set of walings was placed.

Method of Repair

After the cofferdam had been unwatered and the leaks stopped as much as possible, one pump was sufficient to keep the water down so that work could be carried on. The bottom inside the cofferdam was then cleared and the work of underpinning the pier was begun. The excavating for the underpinning was done in alternate sections of about eight feet and was carried in under the pier from four to six feet. As soon as one of the sections was excavated it was immediately filled with concrete which was carried out about four feet beyond the old masonry, thus forming a footing for the concrete casing that was built around the pier to a height well above high water.

The casing was 3 ft. thick and was reinforced with ¾-in. rods placed 2 in. from the old masonry and spaced

15 in. apart both horizontally and vertically. These rods were anchored to the face of the pier with anchor bolts. Old 56-lb. rails were set up in the footing as vertical reinforcing at the face of the casing, to which ¾-in. rods were attached. These rods were placed on 15-in. centers. After the placing of the reinforcing had been completed, the forms were built and the concreting of the casing was started.

The mixing plant was set up at the end of the bridge on top of the embankment and the concrete transported to the pier in 1-yd. buckets by the locomotive derrick, being lowered to a hopper on the cofferdam from which it was conveyed to the forms in chutes. Much of this work was carried on during the winter while the river was frozen over, but on two or three occasions the ice broke up and jammed against the cofferdam and pier, causing the water to raise several feet in a few minutes. Fortunately, however, the men were able to escape without injury.

The same road had occasion to make repairs to the under-water portion of a concrete pier in about 16 ft. of water, where practically the same type of cofferdam as that described above was used and two 12-in. centrifugal pumps were employed for unwatering. Being located in northern territory, the river was frozen over for two or three months in the winter so that it was possible to set up a pile-driving outfit on the ice for driving the steel sheet piling for the cofferdams. Working platforms for supporting the pumps were built on the tops of the piles.

Some time prior to the undertaking of these repairs, divers had been employed to make an inspection of the structure. While this inspection revealed a very serious condition caused by disintegration of the concrete, it was found, after the unwatering had become advanced, that conditions were much worse than had been expected. Owing partly to the poor quality of the concrete, as well as to heavy movements of ice in the spring, severe scouring and crumbling had taken place all around the pier until only about one third of the original area at the base remained. Air chisels were used to cut out the old concrete in alternate sections about six feet long, extending into the center of the pier, each section being built up with new concrete immediately after the old concrete had been removed. Succeeding sections were cut out on opposing sides of the pier, the second one being carried inward to connect with the first.

Work was carried on night and day until the underpinning was completed. As it was done during the winter months, mostly in subzero weather, extra expense was involved in heating the concrete aggregates and in keeping the site free of snow and ice.

Floods Cause Damage

A brief outline of the methods used in examining and repairing foundations of bridge structures that were affected or damaged by the floods in Central and Southern New York in July, 1935, as furnished by the railroad involved, is given below:

Immediately following our arrival at the affected area it was decided to examine the foundations of all bridge structures spanning waterways. Our bridge inspectors were organized into parties of two, and two diving outfits (diver, men and equipment) were hired. The two bridge inspectors were supplied with ½-in. pipe in multiple lengths with the necessary couplings, which could be built up for various lengths. On the lower end was attached a 3-ft. pipe making an angle of 90 deg. with the main shaft. With this appliance it was easy to determine whether there had been any scouring and if it had cut underneath the bottom of the masonry. If scouring had occurred under the bottom of the masonry, the diving outfit was assigned to make a further and complete examination of conditions; the diving outfit was also used where conditions would not allow examination with the pipe alliance. It was remarkable how closely the inspector's report of the conditions checked with the diver's report, as neither outfit knew of the findings of the other.

Divers Have Proved Useful in Pier Investigations

When the scouring under the bottom of masonry foundations was slight, that is, where it extended a few feet back from the face of the masonry and was only a few feet in depth, the repairs were made as follows: The diving outfit was employed to place loose cloth bags, containing a mixture of dry sand and cement, in uniform layers similar to the laying up of a stone wall. After this was accomplished, stone ballast was dumped and spread in and around the work. In addition, heavy rip-rap of various sizes was placed (not dumped) over and around the stone ballast and carried out beyond the ballast to afford protection against further scour. Too much care cannot be exercised in placing heavy rip-rap in order to obtain the desired results.

Major Repairs

In making major repairs to foundations necessitated by heavy scouring, a different and more expensive method had to be resorted to. In one case the scouring had cut out the material under the bottom of a masonry pier to a depth of 17 ft., in another to a depth of 12 ft. At several other bridges the scouring was found to have cut under the foundations to depths of 4 ft. to 8 ft. entirely across the widths of the piers for portions of their lengths. In two cases the scour extended the full length of the pier. All of these structures were founded on wood piles.

In the worst cases we immediately dumped stone ballast around the piers to stiffen the piles. Steel sheet-pile cofferdams were driven around the piers clear of the footing courses. The stone ballast was worked around the piles and leveled off, and excess stone was removed. Grout pipes on about 6 ft. centers were set in the stone ballast, after which the space inside the steel sheeting was filled with concrete. After the concrete had set, a grout pump was used to force the grout through each pipe at a pressure of approximately 300 lb. per sq. in. In this manner it was possible practically to fill all small voids in the stone ballast. That this result was accomplished was borne out by calculations of the amount of grout used and the volume of fine cracks in the masonry. After this work was completed, the foundations were further protected by carefully placing (not dumping) heavy rip-rap of various sizes.

Another road described the procedure followed in making repairs to a bridge over the Wisconsin river as follows:

This bridge consists of four 150-ft. riveted through-truss spans and six 80-ft. deck plate-girder spans built in 1912. The concrete piers rest on a natural sandstone ledge. In 1933, after a season of high water, soundings were taken which indicated that the sandstone was being eroded to a considerable extent in the vicinity of pier No. 2 which supports the ends of two adjacent 150-ft. spans. The water here is ordinarily from 10 to 12 ft. deep and in order to make a thorough examination of the footings a diver was employed.

This examination disclosed that the foundation had actually been scoured out from under the pier, although not to such an extent as immediately to endanger the stability of the structure. It was deemed advisable, however, to make repairs in order to arrest the scouring action, and a plan was developed that contemplated the careful placing of rip-rap around the pier base. However, before the work was carried out an alternative plan was developed

and executed. In this plan burlap bags were filled with gravel and cement and lowered into the water to the desired location through a timber chute. In carrying out this work, a shortage occurred in the available supply of gravel, and sand from a pit near the river was then used for part of this protection work.

The work was done in December, 1933, and in May, 1935, another under water inspection was made by the diver, who reported that most of the bags were still in place and well interlocked, but that some of them had been carried away. The inspection revealed, however, that, where the work was carried out as planned, the protection was effective and that the scouring of the sandstone foundation had advanced only where the bags had been carried away and there only slightly.

Stone Piers Built in 1849

From the South we have the following:

In 1926 we did some unusual underpinning work on our bridge over the Hiwassee river near Charleston, Tenn. This crossing contains three 126-ft. through-truss spans carried on stone piers originally built by Prof. Trautwine in 1849. The superstructure has been renewed several times but no deterioration was noticed in the piers until the early part of 1926 when the piers began to crack shortly after heavier power was placed in operation. A cofferdam was placed around the pier that was cracked most severely and, after unwatering, it was found that the stone piers had been built on a timber crib consisting of black poplar, which rested on a bed of coarse sand and gravel about 10 ft. thick overlying solid rock. The cracking was found to be due to the fact that the sand had washed out from between the two top layers of the cribbing, allowing the timber to crush under the increased loading.

As this stream is subject to frequent freshets, making it difficult to maintain falsework, it was decided to reinforce the footings and jacket the piers, which was done in the following manner:

A row of heavy steel sheet piling set about two feet beyond the outer limit of the timber cribbing was driven down to solid rock. This piling was cut off and capped with a 6-in. bearing angle at about the elevation of the top of the timber blocking. Working a small section at a time, all sand between the old blocking was cleaned out and the space back-filled with concrete. A reinforced concrete jacket was carried down outside the steel sheet piling to a depth of about 4 ft. below the bed of the stream. In order to distribute part of the load over the steel piling, the jacket was heavily reinforced and well tied into the concrete in the openings between the timber cribbing. In addition, this jacket, which was 1 ft. thick, was extended to the under coping and entirely enclosed the original stone masonry. In this manner the steel sheet-piling acted as a bearing pile, and, in addition, by being driven to rock, precluded any possibility of further scouring under the old pier. The work was carried out with considerable difficulty, as the cofferdams were flooded several times before the work was completed. The repairs seem to have been entirely successful as no further settlement or cracking in the piers has been noticed since the work was completed in 1926.

Only Typical Cases

The members of your committee represent many of the major railway systems of North America and the information contained in this report is based on the experience of these members in solving and overcoming difficult problems in making under-water repairs to bridge structures. However, the limitations of time and space have permitted the recording in this report of only a few typical cases from the North, East, South and West.

Because of the difficulties encountered and the expenses involved in making major under-water repairs it is important that frequent and thorough inspections should be made of the under-water portions of our bridge structures so that steps may be taken to arrest the progress of any scour or erosion. In many instances a remedy may be applied at the time of inspection in the form of rip-rap or bags of dry concrete, or by the caulking of joints, at a very low cost, thus removing the necessity of later performing a major repair operation.

Where there is evidence of scour that cannot be averted by the use of rip-rap, steel sheet piling should be driven around the structure to bedrock, if possible, or to a depth insuring safety against scour, and the space between the piling and the masonry filled with concrete by the "tremie" process, thus avoiding heavy cofferram construction and unwatering expenses.

In the construction of new bridges it may be well to consider the use of steel sheet piling in the cofferdams with a view to allowing it to remain in place as a protection against scour and erosion and as insurance against future under-water repairs.

Committee—E. C. Neville (Chairman), bridge and building master, C. N. R., Toronto, Ont.; T. W. Pinard (vice-chairman), engineer bridges and buildings, Penna., New York; L. R. Garman, bridge and building inspector, Penna., Cleveland, Ohio; Maxfield Bear, chief concrete inspector, C. & N. W., Chicago; G. W. Rear, engineer of bridges, S. P., San Francisco, Cal.; G. L. Sitton, chief engineer maintenance of way, Southern, Charlotte, N. C.; W. H. Harrison, bridge and building master, C. P. R., Toronto, Ont.; T. P. Soule, general supervisor bridges and buildings, N. Y. C., New York; J. S. Huntoon, assistant bridge engineer, M. C., Detroit, Mich.; J. G. Sheldrick, resident engineer, M. St. P. & S. Ste. M., Minneapolis, Minn.

Discussion

T. B. Turnbull (Ann Arbor) described an instance in which, despite obvious signs of failure in an abutment, no evidence of scour was found until after marked settlement had taken place, at which time a careful inspection was made by a diver who found that the foundation material under the abutment was deeply scoured. As a result of this and similar experiences, Mr. Turnbull has become convinced that the use of a diver is the only satisfactory means of making inspections of substructures in deep water.

C. N. Billings (S.P.) told of a case involving a bridge constructed across the Brazos river in 1895, in which the foundation under one of the piers was scoured out to such an extent that only one-third of the bearing area remained. To correct this situation, he said, a cofferdam of steel sheet piling was driven, after which the pier was encased in a concrete jacket, heavily reinforced and securely bonded to the pier.

H. I. Benjamin and J. H. DeBord (both S.P.) told of the use of bearing piles consisting of three 75-lb. rails welded together and pointed at the lower end. These piles, they said, have the advantage that they can be given greater penetration under difficult driving conditions than other types of piles. In one instance, where 40 such piles were driven under an abutment, they were driven 2 to 3 ft. into sandstone, a No. 2 steam hammer being used for this work.

W. J. Lacy (M.P.) stated that he is now contemplating the repair of the pivot pier under a draw span which has been settling slowly for some time. Inspection by a diver has shown the foundation under this pier to be deeply scoured. Mr. Lacy said he plans to underpin this pier with concrete and then to apply rip-rap to prevent further scour. Another instance, involving a bridge at a location where there was no current in the stream except that generated by passing vessels, was described by G. E. Boyd *(Railway Engineering and Maintenance)*. When settlement of one side of the bridge seat was noted a diver was sent down to make an inspection. He found that the foundation was so deeply scoured that he could walk upright under the abutment for a distance of eight feet from the face.

Maintenance of Railway Roofs

Report of Committee

John S. Hancock
Chairman

THE roof is one of the most important units entering into the construction of a building. However, in the construction and maintenance of buildings, this item rarely receives the consideration which its importance justifies. A roof of good materials, properly applied and adequately maintained will have a surprisingly long life. Many roof troubles are the result of inadequate maintenance rather than of faulty materials or of poor workmanship during application.

Importance of Roof

Since the protection of the contents of many types of buildings depends as much, or more, upon the effectiveness of the roof than upon that of any other part of the building, it is imperative that the roof be maintained adequately. It is also possible to prolong and extend the life and usefulness of many types of roofs by proper maintenance.

It is important that roofs of any type be maintained without leaks. This is especially important if they are supported on timber sheathing. As soon as moisture penetrates to the wood sheathing, decay is sure to start in the sheathing, endangering both the sheathing and the framing. Wood sheathing, as ordinarily used, is a short-lived material unless it is kept absolutely dry. Any moisture held between the roof and the sheathing will promote rapid decay of the wood. When decay starts, it is usually on top of the sheathing, as a result of the moisture that is being held between the roofing and the sheathing. This decay is seldom apparent visually from the inside of the building until it has penetrated through the entire thickness of the sheathing. Roof repairs, or even roof replacement, over good sheathing, is not a serious problem. However, when sheathing or framing is weakened by decay, both repairs and renewals become major operations.

Specifications for the application of roofing materials are not included in this report. It is recommended that the manufacturer's specifications be followed, except where additional requirements become necessary. Also, it has been considered inadvisable to include roofing information in this report, which is readily available in other railway publications. Many splendid reports relative to roof specifications and roof construction are available. A bibliography, showing where information on this subject can be obtained, will be found at the close of this report.

Asbestos Cement Shingles

Very little need be said about the maintenance of good grades of either natural slate, tile or asbestos-cement-shingle roofs. The life of a roof of any of these materials will approximate the life of the building and will depend chiefly on the life of the fastenings used. In patching a tile roof, if the original pattern of tile cannot be secured, it may be possible to remove the old tile from a part of the roof which is not exposed prominently to view, replace it with the nearest duplicate available and use those that have been removed for repairs. Cracked or broken slate, tile and asbestos-cement shingles can be replaced in kind, or, if not too badly cracked or broken, can be patched with plastic roof cement troweled on, or applied with a caulking gun. Broken slate can sometimes be replaced with metal painted the color of the slate.

One road that has had extensive experience in maintaining slate roofs reported that where fastenings have failed and slates have loosened and cracked, satisfactory results have been obtained by coating the entire roof with cold liquid asphalt applied with a brush, while in other cases, a plastic asphalt coating was applied with a trowel with equal results. These coatings filled the spaces between and under the slate, holding them in place. Asphalt coatings should be free of acid content, however, as the acids tend to disintegrate the slate.

Another method used by this road to carry a slate roof after the fastenings begin to fail is to bore small holes in the individual slates with an electric drill and renail them; the nail heads are then covered with plastic cement.

Where it is necessary for men to walk over roofing of any of these types to take care of skylights, monitors, etc., permanent walks should be provided to keep them from treading directly on the roofing.

Metal Roofs

Good quality tin and galvanized-iron roofs give long and good service if not exposed to deteriorating fumes or gases, provided they are kept well painted. However, usually there are places in the roof that cannot be reached readily by paint, where corrosion is likely to occur and gradually damage or destroy the roof. Either red-lead or sublimed-blue-lead paint is recommended for painting directly on the metal surface. A second coat of red lead, colored to suit, is satisfactory for a second coat. Also, a good graphite, carbon or asphalt paint is satisfactory for a second coat.

Wood Shingles

The life of a wood-shingle roof can be extended slightly by the application of a good grade of creosote shingle stain either sprayed on or applied by brushing. However, decay in old wood shingles is often found within the first inch above the lap where it cannot be reached by the stain. In applying the stain, workmen should work from ladders or scaffolding, as walking directly on the shingles may cause more damage than can be offset by the advantage that is gained by the application of the stain.

When a wood-shingle roof has deteriorated to the extent that it is not advisable to repair it, it is recommended that asbestos shingles be applied

directly over the old shingles, provided the rafters are strong enough to take the additional load, and the rafters and sheathing are in good condition. A good grade of slate-surfaced asphalt shingles can also be applied satisfactorily over old wood shingles. In applying either asbestos shingles or asphalt shingles over old wood shingles, it is recommended that slater's felt be placed over the old roof before the new shingles are applied. Only a good heavy-weight asphalt shingle should be used. A light-weight shingle of this type tends to curl up and will not lay sufficiently tight to keep the rain from blowing in under the shingles. The application of prepared

An Asphalt Shingle Roof

roll roofing over old wood shingles is not recommended, except on unimportant buildings, since such application is usually unsightly.

However, in case prepared roofing is used, it should be cut in strips approximately 13 ft. long and laid face down on a flat surface for 24 hours before applying, which will allow the felt to stretch and thus to some extent prevent wrinkling. In using prepared roofing, it is well to check on the actual weight of the roofing furnished. The full weight of the material specified should be in the roofing itself. Some manufacturers are prone to include the weight of the nails and roofing cement in the weight of the roll, with the result that the roofing itself is from 1 to 2 lbs. short of the weight specified. This may seem a rather small item, but when roofing is purchased in large quantities, it represents a considerable loss.

Nails for applying asbestos shingles over wooden shingles should be barbed and should be 2 in. long. For asphalt shingles, a length of 1½ in. should be sufficient.

Before applying any type of roofing over old wood shingles, all badly warped wood shingles should be split and nailed flat and all loose shingles should be nailed securely. If asbestos shingles are to be used, it is recommended that valleys be filled to the level of the wood shingles with boards of the correct thickness and new valleys built. If asphalt shingles are used, heavy roll roofing, 18 in. wide, may be cemented down to the old valley and a strip 36 in. wide cemented to the narrow strip to form the new valley. All flashings should be inspected carefully and if not of copper, zinc or lead, or if not in first class condition, they should be replaced with new 16-oz. copper if asbestos shingles are used, and 24-gage galvanized pure iron in case asphalt shingles are used.

Asphalt Shingles

Roofing of this type should require little maintenance during the life of the shingles. Any loose or warped shingles can usually be secured by applying plastic roof cement to the bottom edge at the center of the shingle, and then pressing the shingle back into position. Sometimes it is necessary to nail down the exposed corners of the shingle, in which case plastic roof cement should be applied over and around the nail head. However, when shingles have deteriorated to the extent that it is necessary to nail down the corners, it is usually advisable to replace the roof, as the shingles will probably crack off at the corners if they are nailed down.

Roll Roofing

Roll roofing requires frequent inspection and considerable maintenance to obtain the maximum life of the material. Before the light oils have evaporated from the original asphalt, leaving the roof dry and brittle, the roof should be given one or more coats of liquid roof coater, as recommended by the manufacturer of the original roofing. This coater should be thin enough to penetrate the roofing and enough coats should be applied to restore the roofing, as nearly as possible, to its original state. If applied in time, one coat should be sufficient. If delayed too long, two or more coats may be necessary.

It is doubtful economy to apply a heavy coating of any kind over old roofing of this type. If the roofing has deteriorated to the point where a heavy coating becomes necessary to prevent leakage, the chances are that the roofing material does not have sufficient value to warrant any expenditure for maintenance, and that any money spent should be applied on a new roof.

When inspecting roll roofing, special attention should be given to seeing whether the roofing is secured along its outer edges well enough to insure that the wind will not whip up a loose section. Either a roll or a built-up roof, which is not anchored securely at the outer edges can be damaged seriously or destroyed by a high wind.

Seams are often a source of trouble. Leaky seams may be repaired by applying plastic roof cement over the seam, embedding a strip of asphalt-saturated fabric, 4 to 6 in. wide, in the roof cement. Over this fabric, another coat of plastic roof cement should be applied, overlapping the fabric on all edges.

Pitch and Gravel Roof

The pitch and gravel roof is still one of the outstanding long-life roofs of today. Applied properly, this type of roof should require little maintenance. In case leaks do develop, they can be repaired by clearing off the gravel and pitch down to the felt at the location of the leak, then mopping on with hot pitch a patch consisting of two or three layers of 15-lb. tarred felt, each successive layer overlapping the preceding one by at least 6 in., then replacing the top coating of pitch and gravel.

Leaks in gravel roofs are sometimes hard to find. The usual practice is to start removing the gravel and pitch from the old roof at the place where the leak is apparent, working up the slope of the roof until the actual leak is found.

When leaks become frequent the felt should be examined carefully. If found to be completely dried out and badly cracked, the roof should be replaced. If it is apparent that considerable life still remains in the felt, the top coating of pitch and gravel may be removed and two layers of 15-lb. tarred felt mopped over the entire roof, using hot pitch. The top coating of pitch and gravel should then be replaced, but the gravel should be cleaned by screening before it is replaced.

If pitch is to be removed during warm weather, it should be removed during the early morning hours while it is still brittle.

Asphalt and tar or pitch do not mix. Asphalt and asphalt-impregnated felt should not be used over an old pitch roof.

Built-Up Asphalt Roofs (Smooth Surface)

When properly applied, smooth-surface, asphalt and rag-felt built-up roofs should require little or no maintenance for several years. If leaks appear, they may be repaired by mopping on two or three layers of felt,

each successive layer overlapping the one below it by 4 to 6 in. on all sides. Plastic roof cement can also be used to good advantage in repairing leaks in roofs of this type.

The light oils in roofs of this type tend to evaporate over a period of years, leaving the roof dry and brittle. As occasion demands, the roof surface should be given a top dressing of hot asphalt to insure the maximum life.

This top dressing of hot asphalt should not exceed 30 lbs. per square (of 100 sq. ft.), as a heavier coating will tend to crack and distintegrate faster than a uniformly thin coating. If such top dressings have been omitted until the original coating of asphalt has weathered away exposing the felt, and the felt shows signs of damage, two additional layers of 15-lb. felt should be mopped on over the entire surface of the roof.

A Smooth Asphalt Roof

It is not advisable to apply a second coat of hot asphalt over a roof that has already been coated once, unless the asphalt is reinforced with a layer of felt, as too great a thickness of asphalt on top of the felt will tend to alligator or check. Any second coating used over a first coating should be an asphalt cut-back material applied in accordance with the manufacturer's directions.

Good results are also obtained in repairing this type of roof by mopping on a coat of cold liquid roofing asphalt without fibre in which asphalt-saturated cotton fabric is embedded, and over which another coat of cold liquid asphalt is mopped.

Eight years is about the maximum life that may be expected from the original top surface of this type of roof without recoating. It is essential that this top surface be maintained in good condition by surface coating, or, if necessary, by the application of additional felt, in order that the life of the roof assembly under this top surface may be preserved and the maximum life and usefulness of the roof be obtained.

Asphalt and Asbestos Felt

It is practically impossible to do a satisfactory job of coating over an asbestos built-up roof, owing to the fact that it is very difficult to get the coating material down into the felt because of the non-capillary action of the asbestos fibre used in the felt. If repairs are necessary, they can be made with plastic roof cement and 15-lb. asbestos felt, or asphalt-saturated fabric.

General

Walking over roofs should be avoided whenever possible. In the case of built-up roofs, it is advisable to mop on one or two additional plys of felt wherever walking is likely to occur.

It is believed that some of the rust-resisting and rust-inhibiting paints developed recently have merit. It is almost impossible to clean all rust from iron surfaces unless sand blasting is resorted to. It is claimed that this type of paint will penetrate through and underneath the rust and will retard further rust action. For spot painting sheet-metal work and skylight frames, a rust-resisting paint of this character might be beneficial.

Special precaution should be taken to maintain flashings and sheet-metal work in good condition.

Asphalt-saturated asbestos-felt or asphalt-saturated rag-felt flashings are satisfactory when applied in accordance with the manufacturer's specifications.

A good grade of caulking compound is believed to be superior to ordinary putty for glazing on skylights.

A cracked skylight glass may be made leak-proof by applying plastic roof cement with a caulking gun or a trowel.

Plastic roof cement should be of asphalt containing asbestos fibre and should be of the proper consistency to allow it to be worked into position with a trowel or a putty knife.

Tar or pitch will usually prove to be more serviceable than asphalt on surfaces where water lies.

Roofs should be inspected at least once a year; two inspections a year are recommended.

Asphalt and pitch or tar will not mix. Asphalt should not be applied over tar or pitch surfaces and tar or pitch should not be applied over an asphalt surface.

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MAINTENANCE OF RAILWAY ROOFS

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Committee—J. S. Hancock (chairman), bridge engineer, D. T. & I., Dearborn, Mich.; F. H. Masters (vice-chairman), assistant chief engineer, E. J. & E., Joliet, Ill.; W. A. Stewart, assistant supervisor bridges and buildings, Cent. Vt., New London, Conn.; W. S. Rich, general foreman, N. Y. C., New York; L. C. Winkelhaus, architect, C. & N. W., Chicago; E. L. Rankin, architect, G. C. & S. F., Galveston, Tex.; E. H. Brown, supervisor bridges and buildings, N. P., Minneapolis, Minn.; T. D. McMahon, architect, G. N., St. Paul, Minn.; Thos. Stang, supervisor bridges and buildings, N. P., Spokane, Wash.

Discussion

The discussion revealed that numerous roads have had difficulty in the application of prepared roofing as a result of laying the sheets horizontally in that the nails tend to cause splitting of the sheathing boards, and one or two members suggested that

where this trouble has occurred it is better to apply the roofing vertically, in which event the nailing can be staggered and the difficulty of splitting overcome. R. D. Ransom (C. & N. W.) called attention to the present practice on a number of roads of laying prepared roofing with a five inch lap and cementing the overlapping edge to the underlying sheet. The advantage of this, he stated, is that the nails are protected and buckling of the roofing is prevented. This is particularly desirable where prepared roofing is laid over old wood shingles. T. B. Turnbull(A.A.) stated that he has been laying prepared roofing up and down on all repair jobs, but that upon new work the roofing is laid diagonally and he has found this to be of special advantage in avoiding splitting of the sheathing with the nails. He expressed opposition to laying prepared roofing over old shingles because hail invariably punctures the roofing at the point where the shingles overlop. He also called attention to the fact that, in general, prepared roofing has failed because nails that were too short have been used. In answer to a question by A. Chinn (Alton) about removing the existing roll roofing before the new roll roofing is applied, several members stated it is their practice to leave the old roofing in place.

Protecting Steel Bridges Against Brine Drippings

Report of Committee

B. R. Meyers
Chairman

THE problem of protecting steel bridges against brine drippings has increased steadily since refrigerator cars were first placed in service, until today it is one of the major maintenance problems on many railroads. A portion of an editorial which appeared in the *Railway Age* about three years ago gives a very clear picture of this problem: "Still another form of corrosion is that to which the tracks and the decks of bridges are subjected by brine from refrigerator cors. This form of destruction is intensified as the traffic in perishables requiring low temperatures is increasing. On roads carrying heavy volumes of such traffic, track fastenings are destroyed in half the normal life secured elsewhere, while the inroads on bridges are illustrated by the fact that a single road is now completing a program of bridge repair and renewal involving the expenditure of more than one million dollars, made necessary solely by this form of corrosion on a limited mileage of its systems."

Further, excerpts from the report of a joint sub-committee on Damage to Track and Devices Due to Brine Droppings From Refrigerator Cars that appears in the 1934 Proceedings of the American Railway Engineering Association, bring out another side of the picture: "As to open-bunker cars, the committee has given consideration to the practicability of equipping these cars with suitable containers for retaining brine between icing stations, as well as the cost of application. It is estimated that it would cost $282 per car to install containers. To equip cars with brine containers would seriously impair their carrying capacity as the containers, when filled, would weigh approximately 12,500 lb. This would essentially reduce the load-carrying capacity of a 40-ton car to that of a 30-ton car and could be overcome only by the application of higher capacity trucks at an estimated cost of $400 per car. The estimated cost of installing brine containers and changing trucks on existing 40-ton and 50-ton cars would be $80,478,000. The foregoing does not take into consideration the cost of tank renewals, repairs, inspection and cleaning, which is estimated would amount to $13,900,000 per year, or the cost of changing trucks on 35,800 30-ton cars."

"The sub-committee, Engineering division, has tabulated estimates received from railroads reporting damage to tracks, bridges and signals, through brine drippings from refrigerator cars which indicate that an annual excess maintenance expense of $2,350,000 is incurred from this cause on approximately 17,938 miles of main tracks. On the basis of this amount of annual damage to tracks, bridges and signals, the capital expenditure which would be justified at 5 per cent interest is $42,000,000."

The foregoing excerpts show clearly that the expense of equipping open-bunker cars with retaining tanks and heavier-capacity trucks is not justified and that maintenance men will probably have to contend with brine corrosion for a long time.

Cause of Corrosion

According to the Transportation division of the Association of America Railroads there were approximately 157,200 refrigerator cars in service in the United States on January 1, 1936. About 13,600 of these cars are used for transporting meat products, in which salt is added to water ice to provide the low temperature required. They are equipped with brine tanks and retaining valves to hold the brine so it can be drained at icing stations and thus prevent leakage while the cars are enroute. The tanks are not always drained regularly, however, and the valves are not maintained in perfect condition, so that there is leakage from many of these cars.

The remainder of these refrigerator cars, except a few specials, are of the open-bunker type, with open drains under the ice compartments. It was intended to cool these cars by ice alone, but today in 20 to 25 per cent of them salt is added to the ice to provide the low temperatures recommended by the Department of Agriculture and demanded by shippers for transporting perishables. This means that there is a steady brine drip from these cars throughout the seasons when cooling is required. To further illustrate, one road operating more than 10,000 miles of lines reports that about 21 per cent of its total car miles are refrigerator-car miles.

Brine drippings from these two types of cars cause a large part of our corrosion, but this is also augmented in many places by drippings from coal and other products which are transported in gondola cars.

However, our interest in the cause of this corrosion is secondary to our interest in the means of its prevention.

Contributing Causes

The causes contributing to corrosion of iron are light, heat, air and moisture. The ore from which almost all iron is obtained is iron oxide, indicating a natural affinity between iron and oxygen. We separate iron from oxygen to make our structural steel and nature is forever trying to reunite them into iron oxide or rust. It is necessary, therefore, to keep the steel subject to brine drippings from being exposed, as brine on bare steel is very destructive.

This brine also attacks and shortens the life of paints, and those roads having a large refrigerator traffic have resorted to special protective materials which are more resistant to this attack than their ordinary bridge paints. On the other hand, the roads having only a small amount of refrigerator traffic are able to keep their steel protected with ordinary paints by painting the affected parts at more frequent intervals than the other parts of bridges which are exposed only to weathering.

No Protection Effective

The committee received information from 35 railroads in the United States and Canada by means of a questionnaire. Only 8 of these roads indicated that their present methods of protecting open-floor steel bridges against brine drippings were effective, and further analysis showed that this minority had only a small amount of brine drippings to contend with. Nearly all of the other roads stated that their methods were only partly effective. Two roads stated that they know of no effective method for protecting open deck bridges and that ballast-deck bridges afford the best protection. This committee admits that bridges with concrete ballasted decks, properly designed and maintained, provide the best protection to the bridge structure against brine drippings, but this advantage does not always warrant the additional expenditure required for this type of bridge, as compared with the open-floor types.

Most of the roads reporting use heavy protective coatings such as special paints, petrolatums, crude oils, asphalt or asphalt products, tar or tar products and bridge cements. No one of these materials was favored by a majority of the roads and many of them use several different types. There appears to be an increasing interest in the use of petrolatums and road oils as these contain a rust inhibitor and do not require the thorough cleaning of the steel surfaces which is necessary with most other materials. This feature has reduced the application costs as much as one-half to two-thirds the cost of thoroughly cleaning and applying paint. One road applies a heavy coating of gas-house tar over graphite paint and then sands the surface. This is reported to stand up very well for about four years.

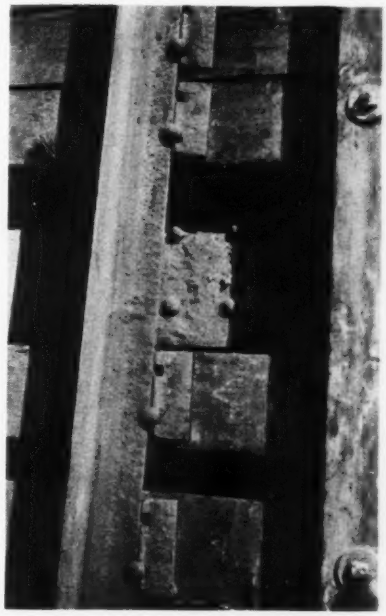
A new system of protecting structural steel has been developed recently. This method is based on the well-known fact that after steel shapes are rolled a mill scale forms and later comes off. If steel is painted in the shop before this comes off, the weathering or aging process is slowed up and may not be completed for three or four years, but when the scale finally is loosened the paint comes off with it.

The first step in this process consists of allowing the steel to weather for from two to six months to loosen up the secondary mill scale. The structure is then given a thorough wire brushing with power rotary brushes. The third step consists of the application of a rust inhibitor made on a phosphoric and soluble chromate base, with a dissolving and dispersing agent to insure penetration. After this, a paint primer is applied which is made of a zinc chromate-iron oxide pigment with a synthetic-resin-base vehicle containing phenol-formaldehyde varnish. The finish coats are either graphite or aluminum with the same type vehicle as in the primer. Very severe tests over a period of about two years show that these materials have about four times the durability, when exposed to ultraviolet rays, moisture, acid conditions and salt brine, of ordinary paints using linseed-oil base. About 15,000 tons of structural steel were finished last spring by this method by the American Bridge Company.

By using this method of steel protection and eliminating shop painting, a smooth flow of material is allowed from the fabricating shop direct to the job without any delay due to waiting for proper conditions for painting. Often parts of the shop coat are marred or scraped off in handling, shipping and erection. The special inhibitor and the paints used in this process cost about 10 per cent more than ordinary linseed-oil paints. A patent to cover this system has been applied for, but all that a person wishing to use the system has to do is to purchase the inhibitor and synthetic paints, with the intent to weather and wire-brush the steel before the application of paint.

Uses Fish Oil

A type of paint used by some roads utilizes a fish-oil-base vehicle which is slightly slower in drying and oxidation than linseed oil. It is claimed to be more durable under brine conditions than ordinary paints, as this material fuses with any small amount of rust and makes it a part of the paint. It has been used extensively for coatings on all types of steel superstructures for about 15 years with good results, although no service records were available to the committee.



Brine Corrosion of a Floor Beam

Another type of coating utilizes a vehicle of pure vegetable gums and heat-treated vegetable oils. This vehicle does not contain either linseed or tung oils and is claimed to be very elastic, to have excellent adhesion, and to be non-porous, making a film, therefore, that is air tight, water tight and gas tight. A zinc metallic pigment is recommended for use where salt brine is encountered. Accelerated tests in a 20 per cent salt-brine solution carried out by a testing company indicated that this coating will protect the base metal four to five times as long as many paints in general use.

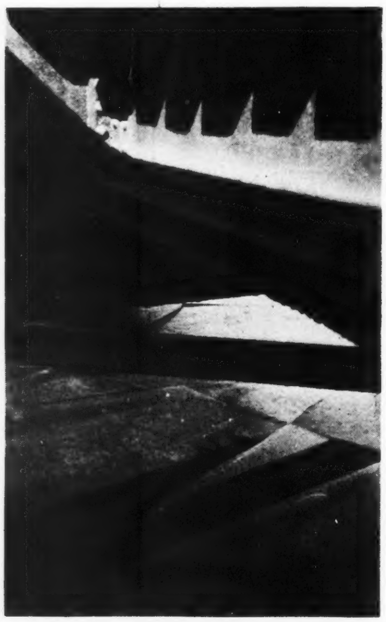
Every maintenance man is familiar with the qualities and durability of red lead in linseed oil, for which reason the committee does not consider it necessary to discuss it in this report.

Most railway men charged with brine-protection work agree that all open accessible parts of the structure subject to brine can be protected if the protective coating is applied often enough. From the few records avail-

able, these applications are necessary at intervals varying from six months to four years, depending on the density of refrigerator-car traffic. This committee was unable to get very much information on costs, but the few roads that did report costs indicated that they were 10 to 50 cents per track foot annually.

Hidden Corrosion Worst

The top flanges of members supporting the deck present a much different problem, as is indicated by the fact that most roads admit that it is not practicable to protect under the ties by the application of ordinary coatings. Corrosion always seems to



Corroded Bottom Flange of Stringer Reinforced With New Angles

be worse at the hidden surfaces and this is true in this instance, as it is generally not economical to raise the deck and apply a coating under the ties as often as is necessary to provide full protection.

One road reports it has solved this problem by placing a $\frac{3}{16}$-in. wrought-iron plate on top of the member throughout its length. This plate is a few inches wider than the top flange of the member to be protected and is held in place by the hook bolts. It is applicable to either open-deck or ballasted-deck spans.

It is common knowledge among railroad men that wrought iron is highly resistant to corrosion, and this appears to be one good way of keeping brine drippings off the top flanges of the deck-supporting members. Several roads are also using wrought-iron plates for floors and ballast stops in steel-plate ballasted-floor spans. This appears to work well in combating brine corrosion and, if provisions are made for quick drainage, will protect the structural steel for many years.

Unique Method Tried

Another road with one line subjected to very heavy refrigerator traffic has resorted to a unique method in this respect. It is explained as follows:

The top flanges of the stringers were corroded sufficiently to cause excessive unit stresses, so a set of angles was applied just below the present ones to restore the original strength. A few years later the corrosion had advanced so far that fillet cracks developed, leaving little support for the ties. To protect the ties, the old flanges were burned off where not already cracked and a tie support consisting of a cover plate with two angles riveted to it, was placed on each stringer. This was fabricated to a tight fit but was not fastened to the stringer except for a few bolts through the new flange angles to hold it down. The tie load is transferred into the web of the stringer by this arrangement. The tie support is not designed to carry flange stress as the remodeled flange has the necessary section. These tie supports were installed easily on a heavy traffic line between trains, as stringer and connections were kept intact and one panel could be worked at a time. They have proven very successful on stringers and have been installed recently on a few deck-plate girder spans.

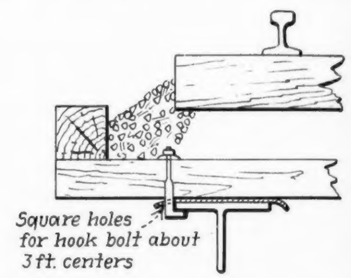
Of course, this is a cure rather than a protection, but the question is raised here whether it is not cheaper to replace the top flanges of stringers which support the deck than to try to protect them against brine drippings. These flanges are somewhat like a chain in that they only need to be reduced at one point in order to weaken the member, so that any protection must be 100 per cent effective.

Still another idea carried out on open deck bridges is to place a tapered wooden spacer block between the ties over the stringer or girder and swab it with a heavy-bodied paint. This carries the brine drippings off to the sides of the structure and is reported to be reasonably effective.

A method described sometime ago in *Railway Engineering and Maintenance,* of soaking a piece of canvas or burlap in red lead and placing it under the tie when the tie is installed, has proven very successful. No doubt there are other methods similar to this one, which have been found to be equally effective.

One other method of protection which is almost untried in the railroad field is metallizing. It appears to have merit, for which reason it will be discussed in some detail.

Metallizing consists of spraying molten metal on a surface. Metal in the form of wire is fed automatically into a reducing flame, where it is melted and, as fast as melted, atomized and projected onto a surface by means of a suitable air blast. These operations are carried on simultaneously by means of a light compact tool known as the metallizer. Any metal that can be drawn into a wire can be sprayed and bonded firmly to



Protecting Top Flanges With a Wrought Iron Plate

any surface without the use of flux or acids. Zinc is about the easiest and cheapest of all metals to spray. It is opaque and, when sprayed onto an iron or steel structure, will deflect the chemical rays of the sun. Zinc is aniodic to iron, so that any electro-chemical action between zinc and iron will be from the zinc to the iron. Most metals oxidize progressively but zinc does not. As zinc oxidizes, a deposit of oxide or carbonic salts is formed. This coating is tough and adherent and stops effectively the penetration of air and moisture, so that further corrosion ceases. Zinc then is an inhibitor rather than a prohibitor. Thus the protection of iron and steel is obtained by simply applying a coating of zinc heavy enough to allow the formation of salts to offset the zinc going into solution, for it is the salts of zinc rather than the zinc itself which afford protection.

Table 1 shows the breakdown times of various pieces of metallized steel tested under the direction of a Canadian railroad by the Canadian Inspection and Testing Company in 1934. The daily cycle of this test consisted of subjecting the test piece to a strong salt spray for one hour, allowing it to stand in the salt spray atmosphere for seven hours; next allowing it to dry over night, then washing off with water for examination. For comparison, a piece of galvanized sheet was also treated.

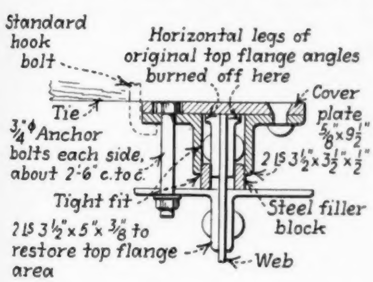
The original cost of metallizing is high, as a very thorough job of sand blasting is necessary for a proper bond. On an annual-cost basis, however, it can be compared to other types of protection, as it is expected that under severe conditions it will give protection for 20 to 25 years. An experimental job was carried out on a Canadian railway where one girder of a deck plate girder span was metallized and the other was spray-painted. Using the expenditures on this special job as a basis, it is estimated that the average costs will be as shown in Table 2.

Table 1

Coating	Breakdown time days
Hot galvanized iron	10
0.003 in. metallized zinc	45
0.006 in metallized zinc	75
0.009 in. metallized zinc	Still o.k. after 90 days

These prices compare favorably with those on many jobs carried out by large oil companies where the insides of large tanks were metallized to protect them against hydrogen sulphide. One of the many advantages of metallizing is that, regardless of the thickness of the coat required, it can be applied at one time and that as soon as sprayed the metal is set. Thus the injurious effect of water or cinders falling on fresh paint or of dragging ties back into place before paint is dry, are eliminated.

It is gratifying to report that many of the roads are now using copper-bearing steel in all new structures, as this metal is more resistant to corrosion than ordinary steel. It also appears to be good practice to make use of this metal or any other structural metal that will resist brine and acid corrosion when replacing members which are badly corroded. In this connection it is desired to restate a portion of the paper presented at this convention a year ago by C. Earl Webb, division engineer, American Bridge Company, as it bears directly on the subject at hand:



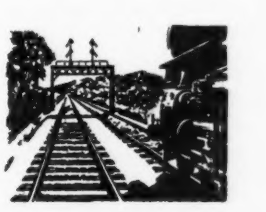
Method of Repairing a Badly Corroded Top Flange

"To my mind, the maintenance of a bridge should be well considered at the time it is designed. For a small additional cost, considerable saving can be made later in maintenance. To cite an example: An additional cover plate $\frac{3}{8}$ in. or $\frac{1}{2}$ in. thick added to the top flange of the stringers and floor beams, or even an extra $\frac{1}{8}$ in. added to the thickness of a required cover plate, or extra thickness in the top flange angles, adds considerable protection against deterioration of the steel from brine drippings. Many bridge engineers overlook the fact that this additional weight increases the total cost of a bridge by a very small amount, and it offers good insurance against early repairs. Consider the stringers in a bridge as having 12-in. cover plates. Increasing the thickness of the top cover plate by $\frac{1}{8}$ in. results in no additional shop labor and only the extra material involved enters into the cost. The increase in the cost per foot of track, considering two stringers having the thickness of the top cover plate increased $\frac{1}{2}$ in., would amount to approximately \$0.20 per foot. This same reasoning applies to various details which many buyers and designers try to reduce to the limit. In the past, as a rule, bridges have required replacements because of inadequate details rather than because of overstress in the main members. The details should give adequate strength to insure economical construction and easy maintenance."

Other Relief

The desirable way to eliminate brine corrosion of tracks and bridges is to eliminate the brine drip. Since there is little chance of doing this so long as cars of the present type are in service, we look for possible relief from other sources and find two new types of refrigerator cars of rather recent development, which provide adequate cooling temperatures and do not produce any damaging drippings.

One is the mechanically cooled car of which there are now about 146 in service. These cars cost approximately twice as much as the common ice-cooled cars and the maintenance cost is slightly higher, but reports indicate that they are operating satisfactorily and are economical in that stops for servicing are eliminated.



The other type is the dry-ice refrigerator, of which there are about 74 in service. Dry ice is solid carbon dioxide which has a temperature of 109 degrees below zero. Instead of melting, it evaporates to a dry gas and has no corrosive action. One pound of dry ice is said to be as effective as 10 to 15 lb. of water ice. Dry ice now sells at \$37.50 to \$60 a ton, depending on the quantity purchased. However, the art of manufacture is improving steadily and the cost should eventually be reduced to \$20 a ton for large consumers, which will put it on a competitive footing with water ice.

Table 2

Method Used	Labor and material for sand blasting cents per sq. ft.	Labor and material applying coating cents per sq. ft.	Total cents per sq. ft.
Painting entire structure three coats	12	5	17
Metallizing brine sections only with 0.009 in. zinc coat	37	18	55
Metallizing entire structure with 0.003 in. zinc coat, except where 0.009 in. coating was used on brine sections	30	13	43

It also has the advantage of eliminating stops for icing, which tends to speed up train service. Also owing to its high efficiency, it will reduce the weight of the non-revenue loads and provide more storage space in cars.

The committee believes that we may look forward with optimism toward the increased use of these new types of cars which will reduce the amount of brine drippings.

The railroads should protect the parts of bridges subjected to brine drippings by using one or more of the methods discussed in this report and any other means which appear to have merit.

Committee—B. R. Meyers (Chairman) assistant general bridge inspector, C. & N. W., Chicago; Armstrong Chinn (vice chairman), Alton, Chicago; A. S. Krefting, chief draftsman, M. St. P. & S. S. M., Minneapolis, Minn.; H. Cunniff, general foreman painter, D. & H., Green Island, N. Y.; E. M. McCabe, supervisor bridges and buildings, B. & A., Pittsfield,

Mass.; W. G. Kemmerer, assistant engineer, Penna., Chicago; E. B. Brown, assistant supervisor bridges and buildings, M. P., Kingsville, Tex.; B. O. Johnson, assistant engineer, C. M. St. P. & P., Chicago; A. W. Harlow, master carpenter, Erie, Huntington, Ind.; Jas. Ferguson, division engineer, C. N. R., London, Ont., and C. Landstrom, master carpenter, C. B. & Q., Burlington, Iowa.

Discussion

In answer to a question by E. C. Neville (C.N.R.) concerning the practice in protecting the portions of top flanges covered by the ties, Chairman Meyers said that most of the railways that reported paint these surfaces only when the ties are being renewed, to which A. R. Wilson added that little corrosion occurs under the ties—that if there is loss of metal at that point it is usually the result of wear rather than rust. He cited the case of a turntable on which the top cover plates were worn through by tie wear.

L. G. Byrd (M.P.) reported on his experience with the petrolatum compound referred to in the committee's report, which he has used for about four years. In the start this was applied too thin, but it is now put on the steel with as heavy a consistency as can be handled with a paint spray. He stated that his road has also applied wrought iron covers over the top flanges of steel beams and girders, and that the results thus far have been very good.

Mr. Neville stated that his road "metallized" a bridge about three years ago and that to date there has been no sign of deterioration of the protective coating. As the process is an expensive one, it can be justified economically only if its service life is appreciably longer than that of other types of protection. H. I. Benjamin (S.P.) said that tests conducted on bridges subject to salt fogs, which produce a result somewhat similar to but not as severe as brine drippings, had led to the conclusion that as far as fog exposure is concerned, the best method of protection is to apply a good covering of paint over a carefully cleaned surface.

Experience with the petrolatum compound was reported also by C. N. Billings (S.P.) who told how he applied this material to some very old wrought iron beams where the brine corrosion was so severe that 70 per cent of the top flange area had been destroyed and that the webs in some places were rusted through. Since the special protective coating has been applied there has been no evidence of further deterioration. To be effective, he said that the protection must be 1/8 in. thick.

Rebuilding Our Bridge and Building Organization To Meet the Demands of the Recovery Period

Report of Committee

W. B. Mackenzie
Chairman

DURING the depression, the railroads, of necessity, retrenched drastically. Every dollar spent had to show tangible results and it was necessary to stretch each one in order to cover as many projects as possible. Such times called for economy in the maintenance of structures and this in turn called for careful study on the part of those directing the work. It might be stated that as a result of these conditions, the railroad man of today has been graduated from the school of "hard knocks."

The railways of today are being operated more efficiently than the railways of yesterday. Today, efficiency is measured in the time and money that can be saved, whether on a maintenance project or in the movement of a train, assuming that the work is done as well or better than formerly. This boils down to the fact that the men behind the railroads are themselves more efficient. Almost every job is done now with less man-hours than were required formerly.

Faster Trains

Train schedules have been speeded up. Locomotives have increased both in weight and the tonnage they can haul, and are making longer runs at faster speeds. Streamlined Diesel-electric and steam trains are being offered to the public with the utmost in comfort and with sustained speeds hitherto unheard of.

The operation of such luxurious trains on faster schedules, and the increased tonnage of freight trains have created problems for the bridge and building and track departments. The structures and the roadbed must be maintained in first class shape. Bridges must be checked periodically, for line, surface and condition; curves must be in perfect alignment, spiralled and maintained to the correct superelevation. In former times, the bridge and building department, like the bridges themselves, was considered to be a necessary evil, inasmuch as it is a spending department and not revenue producing. However, it plays an important part in the efficient operation of the railroad. If its work is not carried on properly and efficiently all other departments will be hampered.

To do efficient work in the maintenance and renewal of bridges to enable them to stand up under the increased speeds and heavier loading of our modern trains, close co-operation must prevail between the maintenance men in the field and the men in the general engineering office. The maintenance men must be able to understand thoroughly the plans of the various structures they are to work on, as, after all, everything from a track spike to a draw span is covered by some kind of a plan, whether it be a sketch on the back of an envelope, or so many separate drawings that it takes a day or more to go over them all. It is not the plan of the committee to go into great detail with respect to the many projects that are required of the typical bridge and building organization, but to state in a few words the need for specializa-

tion and efficiency in handling work to meet the demands of the recovery period as well as thereafter, for if the railways are to survive they must strive continually to improve their efficiency and the economy of their work.

Many new materials have appeared on the market, particularly during the last six or seven years, all of which claim, some with merit, to be better than the older materials which they seek to displace. The modern maintenance man must be able to discriminate between them and if some are not what they claim to be let it be known. Of these many new materials, one stands out prominently. This is preservatively treated timber. We are aware of the economies to be derived from the use of such timber.

Preframed Trestles

It is becoming the practice on many roads to frame bridge timbers for entire bridges before treatment and ship them to the bridge site after treatment, for erection by the field forces. This practice calls for exact framing of all pieces from a prepared plan, by yard forces. This can be done easily in the case of new bridges, such as overhead structures and some

A Bridge Painting Gang

frame bridges. Unfortunately, this practice has yet not become general. The use of treated timber has steadily increased, however. According to the American Wood-Preservers' Association the wood preserving industry registered an increase of 15.7 per cent in volume in 1935 over the previous year.

Longer life may be expected of treated timber, as compared with untreated timber, if reasonable care is exercised in the field in applying hot creosote to all cut surfaces. Many roads now specify that all timber used must be treated. Ties are framed and bored before treatment. Those on steel bridges having different daps are given a different tie mark, the field forces are furnished a plan showing the location of each tie on the bridge. Even with correct plans and with everything thought to be carefully provided for, things may go wrong and upset the apple cart. In come cases, the camber in the girders is not the same and the foreman may find, unless levels have been run over the structure before hand, his seemingly perfect deck may look like a mountain ride. A certain amount of good judgment must be used in all such cases, particularly where an odd shim must be placed here and there under the treated timber.

Steel-Bridge Gangs

As the name implies, these gangs work on the steel bridges on the system, doing so under the direct supervision of the bridge engineer and his staff. These gangs must be able to do any task from straightening rollers to constructing coffer dams around piers for renewals.

With greatly increased engine loading on our main lines, the steel bridges must often be given preferred attention. Generally, a well laid out program of strengthening and repairing is carried out as a part of the year's schedule. Steel bridges that have been retired from service on certain lines because they have become too light for the loading, are doubled or strengthened and reused for main line service. This work is usually done at the headquarters bridge yard and results, in some cases, in considerable economy through reusing the old steel that has thus been retired.

At present a well planned program of grade separations is being carried out all over the country. Steel bridges are being installed for underpasses with various combinations of wood, concrete and steel.

A well-organized steel bridge gang must be capable of erecting steel bridges of the plate-girder type with girder cars and derricks. It is the belief of the committee that many jobs that have been let to contractors in the past can now be done as advantageously with railroad gangs, with proper equipment for handling the work.

Many roads are now doing with their own forces maintenance, as well as addition and betterment work, which was formerly considered exclusively contract work. Paint gangs have been organized and equipped with sand-blasting and paint-spraying equipment. These gangs, operating over the entire system, clean and paint bridges out of face on each division with considerable saving over the old-time system of patch painting certain bridges.

Concrete gangs have been organized for work on each division, con-

Emergency Work Is Often Necessary

structing concrete boxes, abutments and other structures where necessary. Concrete piles and track slabs are constructed by railway forces at a central plant and shipped to site ready for installation. This work is being done economically as gangs become experienced and is being handled without the need for constant supervision by inspectors, as is required on contract work. The maintenance man of today is not slighting any work, however small.

Need for Specialization

With the constant increase in the weight of railway equipment, in speeds and in the demand for safety, the bridge and building gang of today must be a highly specialized organization. All material used and required must be reported on special forms. Time must be kept, separating the time worked on individual projects. It has been stated that a bridge and building foreman, having so many reports to make out, must of necessity be almost a certified public accountant. It is not quite that bad, but almost.

Standard specifications are drawn for all large projects and usually include even the smallest piece of material. The maintenance man must be able to say definitely whether the specifications are being adhered to.

The American Railway Engineering Association is doing outstanding work, constantly seeking better methods of performing work and preparing standardized plans and specifications. Its Committee on Economics of Railway Labor has for 17 years been studying the problem of recruiting, training and employing engineering and maintenance of way

forces most effectively. At the annual convention in March, 1935, this committee recommended that, in order to bring young men of ability and education to the railroads, a plan must be devised, similar to that of the industries which are now securing the most capable graduates of the colleges and universities. The railroads must offer these men sufficient inducement to cause them to remain in the service and at the same time train them to assume responsible positions as quickly as practicable.

It is the belief of this committee that much can be done by railroad supervisory forces through personal contact and personal interest to promote individual interest and efficiency among the employees.

The railways of today are going forward through constant research with the view to more efficient operation. Older methods are constantly being scrapped for newer ones. The committee believes that there is still room for research to meet the demands of the recovery period.

Committee: W. B. Mackenzie (chairman) assistant bridge engineer, St. Louis-San Francisco, Springfield, Mo.; J. E. Bird (vice-chairman) supervisor bridges and buildings, N.Y.C., Corning, N.Y.; C. A. J. Richards, master carpenter, Penna., Chicago; V. E. Engman, chief carpenter, C.M.St.P.&P., Terre Haute, Ind.; F. W. Hillman, assistant engineer maintenance, C.&N.W., Chicago; F. E. Weise, chief clerk, C.M.St.P.&P., Chicago; A. T. Hawk, engineer buildings, C.R.I.&P., Chicago; W H. B. Bevan, assistant district engineer, C.N.R., Toronto, Ont.; G. A. Rodman, general supervisor bridges and bldg., N.Y.N.H.&H., New Haven, Conn.

The Inspection and Maintenance of Water Tanks

Report of Committee

THE uninterrupted functioning of our steam railway transportation system depends on the use of water tanks and other water reservoirs. The movement of every ton of freight and every passenger requires a definite quantity of water, for which reason the supply must be adequate and dependable. This is accomplished in part through the use of water tanks.

Tanks used in railway water service are of practically every kind and type, while the materials used in their construction include timber, steel and concrete. The wooden tank was the first type used on the railroads and it is still used more extensively than any other type. Steel tanks are also used to a large extent, particularly since the conical bottom was designed. Concrete water tanks are used only to a limited extent.

R. E. Dove
Chairman

Inspection

The frequency with which a tank should be inspected depends on the type, its age and general condition. Obviously, there will be little necessity for the inspection of a new tank for two or three years after its construction, whereas one nearing the end of its life should be inspected at 60-day intervals, and sometimes more often. However, regular periodic inspection is essential for safe and proper maintenance and to eliminate those emergencies and failures which have occurred all too often in the past.

Furthermore, by periodic inspection, conditions hazardous to engine and water service men can be detected before an accident occurs. As a rule, water tanks and appurtenances are given closer and more detailed inspection than many other structures because of their importance to train operation. With the advent of automatically-controlled pumping equipment and the elimination of constant attendance, closer inspection is required than formerly when there were regular attendants at all plants.

Most railroads make an annual inspection of their tanks, and some a semi-annual inspection. The annual inspection is made in the fall and the semi-annual inspections in the spring and fall, respectively. They are generally made in connection with the building or the bridge and building inspection. They are also supplemented by quarterly or monthly inspections by water service foremen, mechanics, and water station attendants and irregular inspections by the division engineer, bridge and building supervisor and building foremen. Quarterly, monthly and other inspections are more or less superficial, as the tank is observed frequently by local forces who thus are constantly familiar with its condition. Some roads, however, require complete monthly inspections and demand high qualifications of the men making them.

The annual inspection is the most thorough, as it is generally made in connection with the preparation of the annual maintenance program. Mainly for this reason, it is made in the fall. Some roads in warm climates find that the winter is more advantageous for this inspection, since the tank can be emptied during the period of light traffic for thorough inspection and repair of the interior.

The Inspection Party

The annual-inspection party on roads having system inspectors consists of the system inspector, aided by an assistant, or accompanied by a division inspector; whereas on roads not having system inspectors, the party consists of the engineer in charge and the bridge and building supervisor. The men making these inspections must know the qualities of wood and steel; they must be aware of the weight of water and its action on the tank and its substructure; and they must know when repairs must be made and when they can be deferred.

The equipment of the party includes a spade or shovel, a pick, a timber bar, a small auger with bit brace, wood dowels, a chipping hammer or a hammer and chisel, a flashlight, and a pencil and notebook or a supply of inspection blank forms. Some parties also include an extension ladder and hand axe. For the intermediate inspections an inspection bar is generally all the equipment that is taken along.

There is no uniformity in the size, shape and length of this bar, as it is usually fashioned according to the individual's own idea. It varies from ⅝ in. to 1¼ in. in diameter; it may

be blunt, pointed at one end, or chisel-shaped, with a knob at the other end to prevent injury to the hand when prodding timber; sometimes it is pointed at one end and chisel-shaped at the other.

The inspection books and forms have a very important place in the inspection equipment. Some forms are made up specifically to cover water tanks and their appurtenances only; others include bridges and buildings. Space is provided for the names of the inspectors, the date of inspection, the location of the facility, a description of the part of the structure being inspected, its condition and an estimate of the repairs required. Still others provide for an estimate of the cost of the repairs, including labor and material, while some require a complete description of the work, showing all material required, with the number of pieces and sizes of lumber and hardware, and the amount and kind of paint and other material. This bill of material aids greatly later on in making the requisitions. In making the entries, rough sketches help to clarify any unusual work.

The inspection of a water tank actually begins upon the approach to the structure, when the inspector looks to see whether anything unusual can be noticed. If the tank sets on wooden sills, the ground should be excavated to expose the timber, which is then sounded with the inspection bar. This is not necessary if the foundation is relatively new, except in termite territory, where excavation is always advisable. In territory not infested with termites, the wood need not be exposed until it has been in service long enough for decay to start. Where treated wood has been installed properly, there should be no necessity for uncovering it for inspection, unless settlement is evident.

Defects in concrete or stone foundations are generally above the ground line, so that a superficial inspection is usually all that is required, the inspector sighting across the tops of the piers to note uneven settlement. The condition of the ground surrounding the foundations should be observed for possible scour as a result of unexpected leaks, failure of the tank valves or carelessness on the part of enginemen when taking water.

How to Inspect Tower

The husk frame or tower, including the posts, bracing, caps, floor joists and chime, is then inspected. The bottom ends of the posts are noted particularly for signs of crushing and brooming, as moisture has a tendency to collect at these points, with resulting decay. Tapping with the hammer or the knob of the inspection bar will often detect unsound timber. In termite territory the cracks in the timbers should be inspected carefully for pellets. If the sound of the tapping and the age of the structure are such as to arouse suspicion, or if signs of termite infestation are present, it is well to use the auger to determine the condition of the wood in the center of the post.

After withdrawal of the auger and careful scrutiny of the borings, the hole should be plugged by driving a wooden dowel and trimming it flush with the surface. The bracing and tie rods should be shaken to ascertain whether they have become loose. The caps and floor joists should be observed carefully for signs of bulging of the sides, denoting crushing, since crushing of these members permits some movement of the floor, breaking the chime.

Joists ordinarily decay at the top and ends due to the moisture that permeates through the bottom of the tub. They often appear to be sound, but decay may be detected by sounding with the hammer. The bracing, tie rods, caps, joists and chime are reached by climbing around on the bracing and by the use of a ladder, if available.

Frost Box Gives Trouble

While climbing around on the tower, the fit of the frost box at the tank floor should be observed, since it is important that it be frost-proof. The wood of the frost box should be tested thoroughly with the bar for decay and for termites, both inside and outside and, when necessary, part of the wood should be torn away to permit examination of the intermediate layers. Deterioration of the box is more rapid on the inside and around the outside at the base. Renewals or repairs to the insides of frost boxes are expensive and are seldom practicable; this work is usually deferred until renewal of the entire box is made, say, within the following two years. Provisions for heating should be viewed from a safety standpoint in order to eliminate fire hazards.

If the appearance of the ground under the tank or the condition of the bottom of the tank indicate leaks, the wood underneath the tub and around the chime should be examined. A general idea of the condition of the staves may be obtained from the stationary ladder. Likewise, the hoops should be examined as far as they can be reached from the ladder, using a hammer and chisel. Too much importance cannot be placed on the physical condition of tank hoops, particularly flat hoops.

Flat hoops will rust from the inside due to contact with the moist staves, and as a rule, the worst corrosion will occur near or inside the lug. Their condition can best be ascertained by removing them from the tank. If it is not practicable to do this, their condition can be ascertained fairly well by the use of a testing hammer or punch, if care is taken in making this inspection. The condition of round and half-round hoops can be ascertained readily without the use of tools or removal, as practically all of the hoop is visible. The threaded portion within the lug is of equal importance, and if there is any doubt as to the condition of the hoops, either flat, round or half-round, a number should be removed for inspection.

Ladders Must be Safe

The condition of ladders and roofs are of particular importance from the safety standpoint. Ladders should be inspected carefully, particularly the nails used to hold the rungs to the side supports of wooden ladders, as the nails may rust out underneath, causing them to be unsafe. The roof hatch should be examined to see that it is in a safe condition and so constructed that the cover will not blow off. Roof timbers should be inspected carefully to insure that there will be no possibility of failure which might cause personal injury.

Roof boards and roofing should not be permitted to reach the stage where there is possibility of their blowing away and thus creating danger. Generally, it is not important that the roofing on a tank be watertight; it is maintained to keep the tank as nearly frost-proof as possible and to keep out birds and foreign particles in the air. Dead birds, bird's nests and dirt will clog pipes and cause failures, while nests around the edges of the roofs are fire hazards. In tanks having float valves and float switches, it is important to maintain the roof in good condition. In the colder regions where tanks are made frost-proof by sealing the tank over the roof beams, the wood is subject to rapid decay and caution should be exercised to see that it is in a safe condition.

There does not appear to be any set practice about emptying the tank to permit inspecting the interior. Little decay of the staves occurs in the portion that is constantly submerged, but decay occurs at the upper portion where the water surface varies. For this reason, many inspections are made with the water partially drawn off from the tank to permit observation of the staves at the usual water line. The most common procedure, however, seems to be to wait until

the tank is to be emptied for cleaning, to inspect the inside.

At this time a detailed inspection is also made of the inside ladder, the roof-supporting posts, pipe connections, valve and valve-operating mechanism. Also, any temporary repairs that may have been made previously, such as cement patches around the rim of the floor, patching of timber or of metal and sheet rubber over poor staves or bottom plank, may be observed and a better understanding of conditions obtained.

When inspecting old fir tanks, the inspector should give particular attention to the condition of the staves, as this wood has a tendency to rot in the interior of the stave while the surfaces appear to be sound.

All tank fixtures must be examined thoroughly. The valve rope and spout pull-down rope should be inspected for security and tested for strength, as the failure of either of these devices may cause injury to enginemen. The valve lever and connections should be tested. Attention should be given to the cotter keys in the valve-lever and valve-rod connections, for these frequently cause water tank failures when missing.

The frame supporting the tank spout should be tested and all bolts examined. The spouts must be water-tight at joints to prevent leakage and consequent ice troubles in freezing weather. Anchorage at the base of the spout, spout-butt chains, counterweights and counterweight chains should be inspected.

While inspecting the tank, the inspector should observe the condition of the paint, noting this in the inspection report.

The intermediate or monthly inspections are not made so painstakingly. A careful visual inspection is usually sufficient, unless there is apparent settling of the structure, crushing of the sills, blocking, caps or other compression members, and brooming or crushing at the ends of the posts. The valve ropes and pull-down ropes are inspected, and the valve lever and connections are tested. Inspection is also made of the other outside fixtures of the tank.

Steel Tanks

Where steel tanks, or wooden tanks on steel towers, are supported on concrete piers, particular attention should be given to possible uneven settlement, as such a condition throws excess strain upon certain of the members.

While this is true of wooden towers, there are many joints in this type of substructure and it is not as rigid as steel. Wood also shows signs of unusual stress long before actual failure, whereas steel often collapses without warning. The inspector should examine the tower for twisting. The base plates should be observed for corrosion and if the pockets of the steel legs have been filled with concrete, he should look closely for signs of rust between the plate and the concrete as these pockets are not to be trusted. Rust at this location can sometimes be detected by the bulging of these plates, owing to the increased volume of the rust.

The bracing and all other connections should be examined for loose rivets and bolts. The ladder should be inspected carefully.

Particular attention should be given to the interior of steel tanks, and where steel roofs are used the interior of the roofs should be inspected carefully. As a rule, corrosion on the interior of tanks is more severe on the underside of the roof owing to condensation, and also on that portion of the inside of the tank shell that is alternately wet and dry; usually there is little corrosion in the portion that is constantly submerged. The bottoms of flat-bottom steel tanks should be inspected carefully, as it is at this point that failure is most likely to occur. Corrosion of tank bottoms is due to the acids and minerals in the sediment, which attack the metal. Often this cushion of sediment conceals the corrosion until it reaches the stage where extensive repairs to the tank must be made.

A Tank Repair Gang

Maintenance

The responsibility of maintaining water tanks is divided between the bridge or carpenter foreman and the water-service foreman, the bridge or carpenter foreman being responsible for the structural members, and the water service foreman for the operating parts used in taking water and controlling the water supply. These men report to the bridge and building supervisor.

It is the supervisor's responsibility to see that the maintenance work is done properly and at the right time. It is his task to outline the year's work, based on the annual or semi-annual inspection, and to know that the necessary material is on hand, but it should also be the bridge or carpenter foreman's responsibility to see that the tank is maintained properly. He should make the intermediate, or monthly, inspections and report any defects he discovers. This also applies to the water service foreman, except that he should have the authority to make such minor repairs as he finds necessary.

The maintenance of water tanks should be planned so that the work may be carried out with the least interference to operation. In many cases, there are parts of the year when the tanks are used less than at other times. It can also be arranged for repairs to be made when the tank is out of service for cleaning. When possible, where the repairs are to be made by the bridge or building gang, they should be planned to fit in with their regular schedule of work and thus avoid unnecessary moves.

Making the Requisitions

Some roads make material lists after the annual inspection and turn them over to the purchasing department to aid it in obtaining the necessary materials to the best advantage. The same procedure should apply to special tools or equipment not ordinarily carried by the crews which do the work.

Other roads require requisitions to be made three months in advance of the time that the material is actually needed, thus giving ample time to make the purchases, yet avoiding the carrying of a large inventory of materials. In making the requisitions, it will aid the stores department if the tank material is ordered with the material required for the bridge and building work, so that carload lots can be shipped. The shipping date, destination and crew to which it is consigned should be stated clearly on the requisition. Co-operation of the stores department should be secured in having the material sorted so that all lengths and sizes will be as accessible as possible to eliminate rehandling by the crews. Instructions should be shown on the requisition as to the ma-

terial to be loaded on top and the order in which it will be unloaded and used.

Repairs to wooden tanks should be handled carefully to avoid distortion of the tub when jacks are used to put in new members. It is best to use four jacks of sufficient capacity to lift the entire tub for the renewal of caps or sills. Posts may be renewed and wedged up if desired. In some cases, helper posts can be placed and wedged up alongside a bad post to avoid jacking, and this can be done with less help. Such repairs are temporary, of course, but, especially where old tanks are involved, can be made quite easily and the old tank can sometimes be carried for years without distortion or leaks.

Where helper posts and wedges are not desired or where the renewal of caps or sills is necessary, the wood tub can be raised without distortion if four jacks are used, and headers, shores and jack foundations are placed properly. Where posts or sills are to be renewed, the jack headers should be 12-in. by 12-in. timbers, long enough to reach across all of the caps when placed at right angles to them. The jacks should be placed on wide, solid, level blocking on the ground, with squared 12-in. by 12-in. or 10-in. by 10-in. shores reaching to the headers and braced horizontally all around at the bottom and also sway braced on all four sides. The proper lifting point for the jacks is midway between the outside caps.

The same arrangement can be used for renewing caps by placing the new cap alongside the one to be renewed before placing the jack headers, using a three or four-inch filler block between the headers and three caps that are not to be disturbed. After lifting the tub and changing the cap, the old one is let down after the jacks are removed.

Where it is necessary to raise wood tanks they should be raised as a unit. The practice of raising one side of the tub or one end of one cap should not be permitted.

Dap Splices Strongest

It is generally conceded that a bolted dap splice should be used for stubbing posts where an appreciable amount of transverse shear or bending stress, that is, a tendency to buckle, is present in the member. Besides being stronger than the butt-stub with scabs spiked on, the dap splice is neater in appearance and is less susceptible to decay from retained moisture. The length of the splice should be from one and one-half to two times the width of the post, the width of a rectangular post being the greater dimension. Two or three bolts ¾ in. in diameter are usually sufficient.

As a rule, frost boxes will not last half as long as water tanks. A well-constructed tank of redwood or cypress will last 40 to 50 years if well maintained, but a frost box will last only 10 to 15 years unless it is constructed of treated material. For this reason, frost-box construction is often a maintenance proposition. A frost box should rest on the footings of the tank foundation, so that it will be below ordinary frost and not settle away from the bottom of the tank and thus nullify the benefits of the otherwise warm box. It is also well to build a ladder on the inside, to give access to the fittings at the floor of the tank. One frequent cause of frozen supply lines is a slow leak in the back flow valve at the tank floor. The ladder in the frost box provides a means of reaching this point when it becomes necessary to thaw the ice.

How to Heat Frost Boxes

There are many ways of heating frost boxes. One successful method is to install a 3-in. or 4-in. pipe, with a flanged union at the floor of the tank leading out through the roof to serve as a stove pipe, and employ a small brooder stove in the frost box. These stoves are not expensive and will burn 24 hours with one firing. They can be filled or fired by the local section foreman. It is necessary, however, to protect the frost box from catching fire. This can be done by placing the stove on a sheet of iron resting on brackets fastened to the sides of the frost box or by placing asbestos wall board around the stove.

Where electricity is available, a strip heater controlled by a thermostat may be used. Another electric heater is a hot-bed cable wound around the supply pipe from the bottom to the top and return. These hot-bed cables are resistance wire with asbestos insulation and encased in a lead sheath. This heats not only the pipe but the entire inside of the frost box to the temperature for which the thermostat may be set.

One of the most important factors in the maintenance of water tanks is the water level. Tanks often suffer because they are not kept filled, particularly where they are used infrequently or irregularly, and where the pumping is controlled manually. A tank that is properly erected and kept full of water will require little maintenance.

In applying new hoops to old tanks, such as the round type to replace a corroded flat hoop, the water should be lowered in the tank, keeping only enough water for one locomotive. The start should be made at the bottom, removing the old hoops and applying the new, one at a time. The first new hoop should be tightened to hold at least as much as the old hoop did, before loosening the next hoop. The new hoop should be given one priming coat, sufficiently in advance of the work so that it will be dry when used. It should then be painted when the tank is painted, since the tub is generally painted to protect the wood exposed by the removal of the old flat hoops. The water level should be kept two or three feet above the top of each of the hoops as it is being renewed. The new hoops should not be tightened to the limit, but should be drawn up carefully and tapped in places with a hammer to seat them against the staves. After the new hoops are all applied, they should be gone over carefully by the foreman or some experienced man, and all brought to as nearly the same tension, as possible.

Maintenance of the roof at the point where it joins the staves requires careful consideration, as the staves may suffer serious damage from the indiscriminate driving of nails. This can be obviated, where repairs at this point are necessary, by bolting good solid nail ties to the inside of the staves with galvanized bolts and then secure the roof to the nail ties. It is also possible to support the roof joists by the use of bent iron hangers in notches cut in the tops of the staves. Some roads ventilate the tank by means of a perforated iron center post and pinnacle.

Maintenance of Fixtures

Tank fixtures can be maintained economically if done properly and systematically. One of the most expensive items in this connection is the renewal of valve rubbers and the refacing of valves. The necessity for such renewals is frequently caused by neglect. The valve rod and connections should be kept in good shape. Pins should be kept tight and not permitted to remain in place until badly worn. The wear on valve rubbers and valve seats can be greatly reduced if all connections are kept snug and the rubber prevented from sliding on the seat.

Another important item is the lubrication of counterweight pulleys. These are frequently neglected until the hub and pin are badly worn. Careful attention should be given to the knot or hitch where valve ropes are fastened to the valves. These ropes should be replaced before they reach the danger point.

The maintenance of steel towers is

mainly a matter of keeping them clean and painted. Where column foundations are set low, it is important to see that the bottoms of the columns and bedplates are kept clean. An accumulation of cinders, coal dirt, etc., is sure to cause rapid corrosion. Towers around engine terminals or at coal mines require more attention than others by reason of the corrosive action of the gases contained in coal smoke or fumes from burning waste piles.

Likewise, the maintenance of steel tanks resolves itself largely into a task of keeping them clean and painted. The angles, rivets, bolts and other details of the attachment of the roof to the tank are subject to rapid corrosion and should have more attention than other parts.

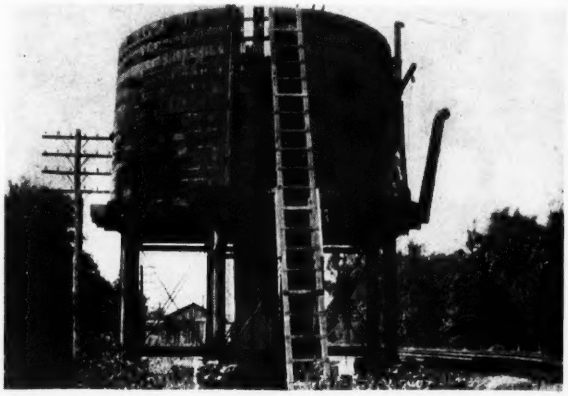
Painting Tanks

No well established practice is being followed in the erection of staging for painting either wooden or steel tanks. Practices vary between different roads and are governed largely by the facilities available. Where a steel tank is equipped with a full revolving ladder, the painting is done from the ladder. In other cases, falsework to support the staging is erected. Sometimes this falsework extends from the ground, while in other cases it extends only from the chime or floor of the tank. The most convenient way to paint a tank is from a stage supported by painter's falls, which consists of two pairs of wooden shell-tackle blocks, each pair having one single block with becket and one double block without becket, reeved with Manila rope and spliced into the becket of the single block. In some cases where the painter uses a seat instead of staging, a single pair of blocks is used.

In using a double pair of blocks with staging it is difficult to swing the falls far enough from the edge of the tank to permit the use of a stage of the required length. This can be overcome, however, by using a special jack or scaffold iron instead of the regular painters' cornice hoops, which will bring the falls out from the edge of the staves. The scaffolding may be swung either from the pinnacle of the tank with lines passing over the edge of the roof, or it may be swung direct from the top of the staves of a wooden tank or the rim of a steel tank. It is necessary, of course, to exercise care in applying cornice hoops or scaffold irons to the tops of wooden staves to avoid damage to the staves and possible accident due to the hooks pulling through the staves.

Spray painting simplifies the problem of scaffolding, as extension spray guns six to eight feet long can be used readily to enable the operator to apply the paint beyond ordinary reach. These extensions are designed to give positive, accurate control of the sprays.

Every precaution should be taken to avoid accidents. Where painters' falls are used, the staging is usually raised and lowered by the men on the staging. The same is true where a painter's seat is supported by a fall.



This Tank Demands Renewal Rather Than Repair

In every case, however, it is advisable to have a man on the ground, both for the purpose of handling material and as an additional measure of safety. Where cornice hoops or scaffold irons are attached to the top of staves of wooden tanks, precaution should be taken to see that the staves are in such condition that the hook will not slip or pull through. To avoid damage to the stave, it should be reinforced with straps of wood or iron. Where vertical ladders are used, the painter should secure himself by means of a safety belt, and ladder jacks should be used where scaffolding is swung from the ladder.

The same rules apply to painting the interior of water tanks. However, the maximum corrosion on the interior of a steel tank usually occurs within the limits of the upper two rings, where the shell of the tank is alternately wet and dry. For this reason, to avoid taking the tank out of service the practice is, in many cases, to confine the painting to these upper rings for a distance of 8 to 10 ft. from the top. In this case, a simple staging can be arranged on floats, using kegs or small barrels. This method has been used successfully in painting the interior of steel tanks on one of our middle western roads for a number of years.

Cleaning Roadside Tanks

The character of the water used determines the frequency with which roadside tanks should be cleaned. As a rule, it will not be necessary to clean flat-bottom tanks more frequently than once a year where the water is obtained from wells, city supplies, lime-soda treating plants equipped with filters, or from reservoirs. However, the tank should be emptied and examined annually, regardless of the amount of suspended matter present in the water.

Where the supply is obtained from a stream which carries considerable quantities of suspended matter it may be advisable to clean the tank twice a year, say, after the fall rains and again in the late spring or early summer. No set rule can be established as to the frequency and time of cleaning tanks, for the reason that the occurrence and amount of suspended matter deposited in tanks depends upon the amount of water used and the quantity and character of the suspended matter carried by the water. The time of cleaning tanks is also influenced to some extent by weather conditions as it is impractical to clean tanks during severe freezing weather.

Where compounds or other chemicals used in treatment of water are introduced directly into the water in the roadside tanks, it may be necessary to clean them more frequently. Sometimes the suspended matter resulting from the application of chemicals direct to roadside tanks is a light flocculent that can be removed readily by emptying the tank or washing it out through the water column line or the washout plug. The removal of heavier material may require the use of shovels. If a spout or trough is made, extending from the opening in the floor almost to the ground, it will avoid spattering the sediment over the tower.

Where unfiltered water from a lime-soda ash softening plant is delivered to a roadside tank, the frequency of cleaning will depend entirely on the efficiency of the settling basin used in connection with the treatment of the water. If ample settling time is provided there should

be no undue amount of deposit in the roadside tank, and it should not require cleaning more than once a year.

Where the roadside tank is a combination storage and treating tank equipped with a sludge-disposal system, it will be necessary to flush the tank one or more times daily, depending on the amount of water used. As with the flat-bottom tank, however, it is necessary to take these tanks out of service at regular intervals for inspection and the removal of sludge deposits that are not affected by the sludging system.

It is necessary to take flat-bottom tanks out of service for cleaning. It is essential, therefore, to make arrangements that will insure that the tank will be cleaned in the shortest possible time. Where the deposit is heavy and requires shovels to remove it, the bottom of the tank should be provided with a washout plug through which the material can be shoveled. If the tank is at an isolated point, the material may be wasted on the ground near the tank. If it is located where such deposits would be objectionable, it may be loaded into cars directly through a chute, if a siding is available; in other cases, it may be necessary to haul it away in wagons. Wherever possible the tank should be washed thoroughly with a hose after the heavier mud has been removed. Where the water is used for drinking purposes the tank should be thoroughly sterilized with hypochlorite of lime or other similar reagent.

The cleaning of flat bottom tanks can be covered by one general rule: Flat bottom tanks receiving filtered water or clear water from wells or other sources, shall be examined internally once each year, and cleaned as often as necessary.

Where conical-bottom tanks with mud drums are in use, the following rule should apply: Conical bottom steel tanks shall be blown off once a week where the water contains considerable mud or sludge, and once a month where water is fairly clear.

The following rule is suggested as a matter of record: The date of cleaning shall be recorded by the division officers responsible for tank maintenance, and shall be shown on the usual tank inspection report.

In closing, it is desired to call attention to the fact that the best of mechanical facilities will function in only a perfunctory manner, or fail entirely, unless their operation is followed up by a careful check system. Furthermore, it is essential for the safe and successful operation of water tanks, that a conscientious inspection be made and that a systematic maintenance program be carried out.

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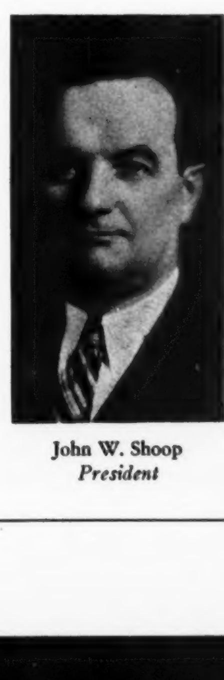
Discussion

Considerable discussion developed about how one can determine when a wooden water tank is near the end of its life, and it was generally conceded that this stage is reached when sufficient leaks develop to make it impossible to carry the tank any longer. The discussion then turned to methods that can be employed to repair tank-floor leaks and a number of examples were given of the application of concrete floors over the existing floor; of the use of clay; the application of asphalt and fabric waterproofing, which has not been entirely successful; and of filling the cracks and chimes with partly dried paint. One of the difficulties encountered in the application of concrete floors is the shrinkage of the concrete away from the staves. It was stated by several members that this difficulty can be overcome by the use of mastic waterproofing compounds or by the use of oakum and asphalt waterproofing compounds to calk the crevices thus formed. Another method which was discussed at some length is the application of false floors, with the floor boards at right angles to the original floor. Special emphasis was placed on the necessity for giving ample support to the false floor to avoid settlement and consequent leaks.

Bridge and Building Supply Exhibit

THE exhibits presented by the Bridge and Building Supply Men's Association have long comprised an important feature of the annual conventions of the American Railway Bridge and Building Association, as manufacturers have placed on display samples or models of the products they manufacture for railway use. The exhibit this year was unusually comprehensive, 40 manufacturers presenting materials and equipment of vital importance in the construction and maintenance of bridges, buildings and water-service facilities. It was worthy of note also that a larger proportion of the companies displayed their products, in lieu of the literature previously presented. For this reason, this year's exhibit was more instructive than in any recent year, the manufacturers' products being displayed effectively. Interest in the exhibit was evidenced by the fact that the exhibit room was crowded except when the convention was in session.



John W. Shoop
President

The officers of the Bridge and Building Supply Men's Association who arranged for and conducted the exhibit were: Pres., John W. Shoop. manager railway sales, Lehon Company, Chicago; vice-president, L. F. Flanagan, representative, Detroit Graphite Co., Chicago; treasurer, D. A. Hultgren, resident manager, Massey Concrete Products Co., Chicago; secretary, W. S. Carlisle, representative, National Lead Co., Chicago; and the following directors—C. H. Johnson, assistant to vice-president, Fairmont Railway Motors, Inc., Fairmont, Minn.; A. J. Filkins, general manager, Paul Dickinson, Inc., Chicago; George R. McVay, special representative, Ruberoid Company, Chicago; K. T. Batchelder, manager railroad sales, Insulite Co., Chicago; Guy C. Mills, Zitterell-Mills Co., Webster City, Iowa, and Earl A. Mann, Modern Supply Co., Chicago.

At the annual meeting of the association on October 22, the following officers were elected for the following year: President, Mr. Flanagan; vice-president, C. E. Ward, U. S. Wind Engine & Pump Co., Batavia, Ill.; treasurer, Mr. Batchelder; and secretary (re-elected), Mr. Carlisle. George W. Morrow, Ingersoll-Rand Company, Chicago, was elected a member of the executive committee to fill Mr. Batchelder's unexpired term, while Earl E. Thulin, Duff-Norton Manufacturing Company, Chicago, and C. C. Rausch, Dearborn Chemical Company, Chicago, were elected members of the executive committee for three years.

The companies participating in the exhibit, together with the products they displayed and the names of their representatives follow:

Air Reduction Sales Corporation, New York; welding and cutting equipment and accessories, samples of welded pipe, carbide lamps, compressed air and nitrogen for operating pneumatic tools, Walseal joints, calcyanide; C. B. Armstrong, C. A. Daley, J. W. Kenefic, R. T. Peabody, E. F. Portell and E. F. Turner.

Armstrong Paint & Varnish Works, Chicago; samples of brine dripping paint, bridge paint and general maintenance paints; L. D. Mitchel and Tom Wyles.

Arrow Tools, Inc., Chicago; Rivet cutting safety retainers, riveting hammers, forged hand tools; W. S. Holmes and H. J. Trueblood.

Automatic Nut Company, Chicago; lock nut, structural ribbed bolt; A. B. Cross and R. J. Voss.

The Barrett Company, New York; roofing specialties, acid resisting paints, roofing cements, roofing materials, tar emulsions, wood preservatives; W. P. Hickman and L. L. Thoms.

Binks Manufacturing Company, Chicago; paint spraying equipment; R. E. Mann and E. F. Watts.

A. M. Byers Company, Pittsburgh, Pa.; model of bridge with wrought iron floors, blast plates, railing and bearing plates—literature on wrought iron; E. S. McCormick and W. J. Wignall.

Celotex Company, Chicago; insulation, wallboard, and cold storage insulation; H. A. Winandy and C. R. Young.

Dearborn Chemical Company, Chicago; rust preventives, sealing compound for wood water tanks, aluminum protective coating for steel, pipe covering for underground pipes; J. A. Crenner, H. C. Moeller and C. C. Rausch.

Detroit Graphite Company, Detroit, Mich.; bridge paints, building paints; L. F. Flanagan and E. C. Roberts.

Paul Dickinson, Inc., Chicago; roof ventilators, smoke jacks, stove jacks, roof drains, exhause heads; Paul Christianson, A. J. Filkins and Stanley Weeks.

Joseph Dixon Crucible Company, Jersey City, N. J.; graphite paints, aluminum paints, waterproof grease for cables, and cup grease for turntables; E. C. Bleam.

The Duff-Norton Manufacturing Company, Pittsburgh, Pa.; automatic lowering and ball-bearing jacks, special jack for pulling drift bolts; C. N. Thulin and E. E. Thulin.

Fairmont Railway Motors, Inc., Fairmont, Minn.; literature on motor cars and paint spray car; C. P. Benning, Kenneth Cavins, C. J. Dammann and J. E. Simkins.

B. E. Hurlbut, Chicago; self-priming centrifugal pumps, paint spray equipment, power timber saws, portable a-c. power plants; J. C. Gorman, B. E. Hurlbut and H. F. Willson.

Ingersoll-Rand Company, New York; literature on pneumatic tools, jack-hammers, compressors and pumps; G. W. Morrow and D. W. Zimmerman.

Ingot Iron Railway Products Company, Middletown, Ohio; model of perforated pipe for bridge deck drainage, bonded metal, metal cribbing and literature on spiral pipe; E. T. Cross and W. P. Greenawalt.

The Insulite Company, Minneapolis, Minn.; building insulation, model of cold storage insulation, combination insulation and building sheathing; K. T. Batchelder and C. S. Johnston.

Johns-Mannville Sales Corporation, New York; samples of Transite pipe, refractories, pipe insulation, asbestos wainscoting and wallboard, mechanical packing, asphalt plank; T. O'Leary, Jr., H. R. Poulson and L. T. Wouhn.

Koppers Company (Tar and Chemical Division), Pittsburgh, Pa.; roofing, waterproofing materials, road tar, creosote, other tar products; H. L. Stockdale.

The Lehon Company, Chicago; asphalt shingles, asbestos shingles, prepared and built up roofing, aluminum roofing paint, waterproofing materials; John Eipper, Tom Lehon, R. J. Mulrooney, John W. Shoop and Harry Wolfe.

Mall Tool Company, Chicago; gas driven and electric driven machines for vibrating concrete and surfacing concrete with attachments for pumping water, drilling, boring, driving lag screws, wire scratch brushing and sanding; A. W. Mall, F. A. McGonigle and F. G. Meier.

Massey Concrete Products Corporation, Chicago; literature on and photographs of concrete pipe, concrete cribbing and crossing slabs; Ross Clarke and David A. Hultgren.

Master Builders Company, Cleveland, Ohio; samples of floor wearing surfaces, rust joint iron, non-shrink aggregate for concrete bonds, reground portland cement paint for concrete surfaces, liquid quick-setting compound; E. L. McFalls, James Stone and B. R. Wood.

Modern Supply Company, Cicago; samples of rebuilt pneumatic tools with hard chrome, bridge reamers and small bridge tools; C. W. Cregier, Earle A. Mann, H. J. Schumacher and A. A. Walker.

Morrison Railway Supply Corporation, Buffalo, N. Y.; samples of structural welding, sample ties and poles treated with Osmose, model of trestle treated with plastic preservative, literature on welding frogs and crossings; George W. B. Diver, Frank Mooney, Marion Morrison and Raymond L. Morrison.

National Aluminate Corporation, Chicago; H. H. Richardson.

National Lead Company, New York; red lead, white lead, expansion bolts; J. O. W. Belt, W. S. Carlisle, F. M. Hartley, Jr., and O. Meyer.

Otley Paint Manufacturing Company, Chicago; pigments, paint panels, bridge and building paints, paint behicles; Walter A. Otley, E. V. Van Patten.

W. W. Patterson Company, Pittsburgh, Pa.; wood and steel tackle blocks; W. W. Patterson, Jr.

Pittsburgh Plate Glass Company (Paint and Varnish Division) Newark, N. J.; paints and waterproofing; W. T. Carey, C. S. Gush, J. G. Mowry and L. F. Theurer.

Pocket List of Railroad Officials, New York; copies of publication; B. J. Wilson.

Railway Engineering and Maintenance, Chicago; copy of publication; George E. Boyd, M. H. Dick, Elmer T. Howson, W. S. Lacher and H. A. Morrison.

The Ruberoid Company (Railroad Division) Chicago; mineral wool insulation, pipe covering, asbestos shingles, roofing and siding, 85 per cent magnesia insulation, asphalt shingles, prepared roofing; G. R. McVay.

Teleweld, Inc., Chicago; model of welded through girder span, adjustable I-bar; C. W. McKee, J. A. Roche and R. R. Swanson.

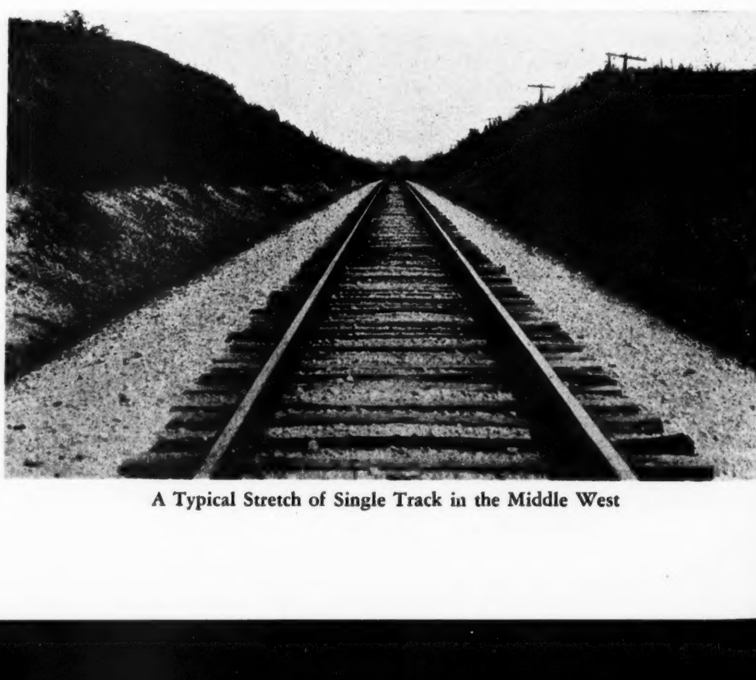
Thompson & Company, Oakmont, Pa.; metal paints and rust inhibitor, model of steel truss; C. L. Boyle, J. L. Crowley, T. C. McKenzie, D. D. Monroe and J. V. Thompson.

United States Gypsum Company, Chicago; interior and masonry paints, asphalt roofing, gypsum and steel decks, asbestos products, board and mineral wool insulation, expanded metal and metal lath products, lime, gypsum wallboard, fibre wallboard, lime products, plaster products; W. J. Berry and John C. Stewart.

U. S. Wind Engine & Pump Company, Batavia, Ill.; valves, water column parts, water service equipment, literature; J. P. Prindle and C. E. Ward.

Yale & Towne Manufacturing Company (Chain Hoist Division) Philadelphia, Pa.; pulling and lifting hoist; R. J. Arehart and R. H. Idwin.

Zitterell-Mills Company, Webster City, Iowa; model of enginehouse; Guy C. Mills.



A Typical Stretch of Single Track in the Middle West

Transposing Rails on Curves

When transposing rails on curves, should they be turned? Why?

Turn One; Not the Other

By C. W. Baldridge
Assistant Engineer, Atchison, Topeka & Santa Fe, Chicago

Experience has shown that the low rail on a curve will reverse its curvature when it is removed from the track after a year or two in service. For this reason, if the low rail is turned when it is laid on the high side of the curve, three things are accomplished. First, the natural curvature of the rail will coincide with the curvature of the track.

Second, where head checks have developed in the rail, these checks always occur on the gage side of the rail. By turning the rail and thus continuing the old gage side as the gage side in its new position, the checks will be in compression and will tend to close up. If, on the other hand, the rail is not turned, the former gage side will be on the outside where lateral pressure will put the checks in tension and they will tend to open up.

Third, since the side wear on the rail on curves takes place on the high rail, the low rail, when turned, will present a full side of the head to the wheel flanges. Furthermore, the former gage side of this rail is harder and more wear-resisting than the other side of the head, because it has been subjected to a process of cold rolling.

Let us now consider the high rail. This rail increases its curvature when it is removed because the cold rolling to which it has been subjected has compressed the metal on the gage side to give a greater density than that on the outside of the head. If this rail is turned it will be necessary to reverse its curvature, thus opening up any head checks which may have been started while it was on the high side of the track. The reversal of this rail will also present the already worn side of the rail head to the wheel flanges. On the other hand, if it is set over without being reversed, it will present the unworn side of the head to the wheel flanges and to the track gage, thus providing better gage for the track and a better wearing surface in its transposed position.

Again, by setting the high rail over without turning it, it becomes easier to keep the bearing surface of the rail within the zone of greatest wear on the wheel tread, thus avoiding the flattening of the low rail by reason of the false-flange bearing of the worn wheels.

As no apparent advantages result from placing transposed rails otherwise, the best practice seems to be to turn the low rail and to set the high rail over without turning it.

Should Not Be Turned

By W. E. Folks
Track Supervisor, Cleveland, Cincinnati, Chicago & St. Louis, Cincinnati, Ohio

My answer to this question is no. Experience and the results of numerous tests have proved to our satisfaction, and this applies more particularly to the low rail, that transposed rail will wear longer if it is not turned than if it is. In making these tests we transposed the rail on some curves without turning it, while on others it was turned.

We found that if the high rail was turned when it was shifted to the low side, it failed rapidly. In many of the rails seam cracks appeared under the head at its junction with the web. We also found that train resistance on the curve was increased noticeably, as compared to curves upon which this rail was transposed without being turned.

Where the low rail was turned when it was shifted to the high side,

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Send your answers to any of the questions to the What's the Answer editor. He will welcome also any questions you wish to have discussed.

To Be Answered in January

1. Should ties be delivered in open-top or box cars? Why?

2. Is it preferable to renew bridge ties out-of-face or individually as they show signs of approaching failure? Why? How should the work be organized?

3. When joint bars are reformed, should they be crowned at both the top and the bottom, or at the top only? Why?

4. What methods should be employed in painting floors or woodwork that have been waxed? How can the paint be made to adhere?

5. What is the proper width of roadbed for single track? For double track? Why? What effect does a roadbed wider or narrower than this have on track maintenance?

6. How should the exhaust system from an internal combustion engine be designed and installed?

7. What precautions should be observed in setting a motor car off the track, to avoid personal injuries?

8. How does one apply sway bracing on a pile bent where the cap is so near the water that the brace plank cannot be applied above the water?

the rails failed more rapidly, although the failures were of a different character. In this case, the flang wear was excessive and the necessity for replacement occurred sooner than on the low rail that had been shifted from the high side.

These tests were conducted on curves of 16 and 17 deg. We found that if the rails were not turned we were able to get 2½ to 3 years more wear on the low side and 4 years more wear on the high side than from rails that had been turned.

Anti-Creepers at Turnouts

Where should anti-creepers be applied at turnouts and insulated joints? Why?

Conditions Differ

By E. L. Banion
Roadmaster, Atchison, Topeka & Santa Fe, Independence, Kan.

Perhaps there are several answers to this question, depending on the class of track and the standards of maintenance. Conditions differ between single and multiple track, and with the density and character of the traffic. If train movements are purely directional, the control of creepage is usually only a matter of applying enough anti-creepers to anchor the track against movement in the direction of traffic. On single track, a study of local conditions must be made to find in which direction the rail tends to creep. Here, there is a marked tendency to creep down grades, at places where braking is done regularly, and elsewhere in the direction of traffic. In general, facing-point switches are avoided on multiple track, but where they occur more anti-creepers per panel should be used for several rail lengths ahead of the turnout to prevent crowding at the switch points and at the wing rail of the frog than will ordinarily be required for a trailing-point turnout.

In placing anti-creepers through the turnout itself, I can see no need for increasing the number, for the holding power on the longer switch ties is greater than on standard crossties. The following reservations to this general statement are necessary, however, on single track and for facing-point switches on multiple tracks: If the switch heel blocks are secured to the stock rails by long bolts passing through the entire assembly, no additional anti-creepers will be needed through the turnout, but they should be placed ahead of the switch. On the other hand, if the heel joint is secured independently of the stock rail, anti-creepers should be placed on the turnout rails. Anti-creepers are not required on frogs, guard rails or rails at the switch points.

For the proper placing of anti-creepers, it is fundamental that each pair shall be placed directly opposite each other and on the same side of the tie, to prevent sluing of the ties. For the same reason, slotted joints should have anti-creepers on the opposite rail. Since insulated joints are not slot spiked, anti-creepers should not be applied opposite to them, but on the shoulder ties each side of the insulated joint.

Apply Enough Anchors

By T. M. Pittman
Division Engineer, Illinois Central, Water Valley, Miss.

Only a general discussion of this subject is possible, since the most effective location for the anti-creepers varies so greatly with local conditions. The fundamental principle which underlies the use of all anti-creepers applies in this case as fully as in others—apply sufficient anti-creepers to prevent movement of the rail—and is more important perhaps around turnouts and insulated joints than elsewhere.

In single track, the rail adjacent to insulated joints should be anchored in both directions, with a sufficient number of anti-creepers to keep it fixed. The number of anti-creepers per panel and the number of rails to be anchored will depend on the tendency of the rail to creep. This, in turn, will depend on the grade and the volume of traffic, but in any case the anchoring should extend for several rails instead of bunching the anti-creepers on one or two rails adjacent to the joint. On double track it will generally suffice to anchor in one direction only, but some conditions require that the rail be anchored in both directions. A close watch should always be kept and additional anti-creepers applied promptly if their need is indicated.

Movement of the main track rails toward the switch point creates a hazard. The point should be about 9 in. ahead of the bend in the stock rail. If the rail moves toward the point there is a tendency for the point to open and cause a derailment. If the heel of the point is bolted to the stock rail, any movement of the stock rail pushes the switch out of line. In the case of a spring frog this movement will cause the guide boxes on the spring rail to bind against the lugs and the spring rail will not close. In extreme cases the lugs will be bent.

It is also objectionable, but not so serious, for the stock rail to run in the opposite direction, and this must be overcome by placing anti-creepers on the side-track rail, anchoring it in one direction only, that is, against movement toward the switch. All anchors to prevent the movement of the main-line rail toward the switch should be placed on that rail. If the main-line rail should move into the switch and the siding rail is anchored to resist this movement, the rail will buckle inward at the bend in the stock rail. The number of anti-creepers and their specific location will be controlled by local conditions, but it is well to emphasize that sufficient anti-creepers should always be used to hold the rail. It is good practice, when laying rail, to increase the expansion a slight amount at all insulated joints and turnouts.

Many Factors Involved

By Jesus Alarcon
Trackman, Atchison, Topeka & Santa Fe, Section House Hawes, Hinkley, Cal.

If rails are allowed to creep toward and through turnouts, the switch points may open, the wing rails of spring frogs may be crowded open and the guides may foul on the boxes. In extreme cases the spring bolt will be bent or even broken, and the track will be badly out of line. So many factors are involved in the cause of creepage, including density, speed and direction of traffic, grades, curvature and the amount and place of braking, that to a certain extent every case is a special one which requires individual study.

There are certain general observations, however, that apply to all cases. It is the creepage that occurs for some distance approaching the turnout, and not that specifically through the turnout itself independent of this outside creepage, that causes the trouble. This gives a clue to the remedy. Anti-creepers should be applied in sufficient number and for a sufficient distance approaching the turnout to stop this movement of the rails. It is advisable, through the turnout itself, to apply anti-creepers to both the running rails and the turnout rails.

In general, the same principles apply to insulated joints. The rail should be held against movement that will crowd the joint in the same manner as on approaches to turnouts, for the fibre bushings which provide the insulation cannot withstand the pressure exerted by rail creepage.

Make Complete Study

By Wm. A. Maxwell
General Sales Manager, The P. & M. Company, Chicago

To obtain the most economical and effective results from the use of anti-creepers through turnouts requires a complete study of the local conditions. Factors which may vary the number of anti-creepers and their placement include: (1) whether the turnout is on single or double track; (2) whether it leads to a passing siding or an industrial spur; (3) the speed of operation over the turnout; and (4) whether loads are equalized in both directions through the turnout.

It is necessary, first, to check definitely all accumulative creepage before it exerts any damaging force on the frog or switch points. Through the use of a few anti-creepers applied in both directions for six or eight rail lengths on the approaches to a single-track turnout, this accumulation can be prevented and the turnout can then be treated as an independent unit with respect to anchorage. On double track, under normal conditions it will be necessary to apply anti-creepers only in the direction of accumulative creepage.

Anti-creepers should be applied from the heel of the points to the toe of the frog and at least two rail lengths beyond the guard rail on the turnout side. The main-track rails are, of course, taken care of by anti-creepers placed at normal intervals.

Insulated joints are the weakest and most vulnerable points in fast-running track, since the insulating fibres do not grip the rails as effectively as the standard joint with its metal-to-metal contacts. Creeping rail and ordinary expansion and contraction are continually cutting or mashing the insulating fibre, causing high maintenance charges and signal failures. It is necessary, therefore, when applying anti-creepers through insulated joints, to use an adequate number of additional anti-creepers for several rails on either side of the joints to reduce to the minimum any accumulative creepage which might exert a damaging force on them. Anti-creepers should never be applied to insulated-joint ties.

Blasting in Deep Wells

Under what conditions is it practicable to use explosives in deep wells to increase the flow of water? What are the advantages and disadvantages?

Only as a Last Resort

By E. M. Grime
Engineer of Water Service, Northern Pacific, St. Paul, Minn.

It is best never to use explosives in a well, except as a last resort. If the hole is deep and in hard rock, and the flow is much less than is required, it is sometimes practicable to break up the formation to some extent and then remove the loosened material from the hole. This will create an enlarged cavity or reservoir for the collection of water and the rock may be fractured in such a way that water passages will be opened up and thus possibly increase the normal flow. In soft sandstone formations, there may be a tendency to pack the material and even decrease the flow if too heavy a charge of the explosive is used. Sixty-per cent dynamite may sometimes be used to advantage, however, in this kind of material and 75-per cent dynamite if the formation is a harder rock.

In some water-yielding rock formations, such as Columbia River basalt, the crevices are partly filled with very fine silt. The discharge of high-percentage dynamite has been successful in opening the crevices in such formations, or at least in disturbing the silt lodged in them, and the flow has been increased considerably for a time. On the other hand, during the time when the well is not being pumped, the silt carried by the water will settle gradually, refilling the crevices. As a result, the shooting and cleaning of well holes in formations of this kind may have to be resorted to periodically to maintain a satisfactory flow.

One should not resort to the discharge of explosives in a well hole unless they can be used at a safe distance below the end of the casing and, preferably, the water should not be allowed to rise into the casing at the time when the shooting is being done. The disturbance created by the explosion, in a column of water extending up into the casing is sometimes sufficient to cause collapse of the pipe and to ruin the well.

The use of explosives may be desirable for the purpose of dislodging boulders encountered in a well hole in such a position that they tend to divert the drill from its true course, which might result in a crooked hole. Explosives are also used to advantage in the oil fields, particularly where there are hard-rock formations. The cases where they can be used to advantage in the development of water flow are not so numerous, and careful thought should be given to the matter before it is decided to do any shooting in a deep well.

Has Limited Field

By C. R. Knowles
Superintendent Water Service, Illinois Central, Chicago

While the use of explosives in oil wells is common, it is somewhat limited for water wells, although there is no good reason why, under favorable conditions, their use should not be as beneficial as in oil wells. Where water is drawn from rock strata, the breaking or fissuring of the rock will increase the area from which delivery of the water to the well is made.

In limestone formations, where the underground water follows more or less definite channels instead of percolating slowly in a broad, thick sheet through the body of the rock, shooting will tend to increase the number of veins contributing to the flow. On the other hand, there is danger of diverting such water as may be in the well into other channels. On the whole, however, shooting the well may be beneficial and probably will determine the success of some wells, since in a limestone region the success of a well depends largely on chance because the diameter of the hole is small and the water veins or fissures are relatively few. It appears that explosives should be used more generally in formations of this kind.

Explosives are also used in wells reaching unconsolidated formation, for example, to break up cemented sand. Shooting a cased well may be dangerous, however, since the explosion is likely to damage the casing, and unless the greatest care is exercised it may do more harm than good. In shooting a cased well, small charges of 60-per cent dynamite should be used, increasing the charge if this is found to be necessary. An individual charge may range from ½ lb. up, de-

pending on the diameter of the well hole and the amount of work to be done.

Large charges are usually placed in tin tubes or otherwise protected by a covering that will exclude water. Gelatine dynamite is not affected by water, for which reason the protective covering is not needed. Small charges should be weighted to insure that they will sink to the desired depth. An electric detonator should be embedded in the cartridge with the wires sealed carefully. If a tube is used, it should have a close-fitting cover, with a small hole through which the wires are passed, and the cover should be sealed with paraffin. The detonator wires should be covered with rubber tape after they are connected to the blasting-cable wires. The charge should be lowered into the well by means of a separate wire or a strong cord to the desired depth and fired with the aid of an electric blasting outfit.

Should Motor Cars Be Covered?

Should motor cars be covered with a tarpaulin when they are set off the track? Why?

Climate Chief Factor

By A. E. Perlman
Engineer Maintenance of Way, Denver & Rio Grande, Denver, Colo.

The climatic conditions encountered on the road or section of road under consideration is the chief factor to be considered in the determination of the need for a motor-car cover. Where heavy snows in winter and dust in the spring and summer are likely to affect seriously the operation and maintenance of the car if it is left uncovered during the day, the cover becomes a necessity. It is also of value as a protection against the elements for the men on the car when they are forced to travel in a heavy rain or snow storm. In mild, arid climates the cost of providing covers is not easily justified.

One of the chief arguments against the canvas cover has been the difficulty of preventing it from being stolen by itinerants, but this has been overcome largely by painting the insignia of the road in the center of the cover where it can be identified easily if stolen. Just as doors on enginehouses are used universally in northern climates, while many roads in the South find no need for them, so the determination of the need for a motor-car cover is governed by the local conditions on the road.

It Is Good Practice

By L. A. Rape
Extra Foreman, Baltimore & Ohio, Wampum, Pa.

There are decided advantages in covering motor cars when they are set off the track and it is my observation that it is good practice always to care for motor cars in any practicable way. When a car is covered properly it will be protected from locomotive sparks, with their fire hazard. A properly applied tarpaulin will prevent the wetting of wiring, coils and batteries, a real advantage since water in the ignition system is extremely troublesome and may make it impossible to start the car. A well-covered car removes temptation from trespassers to steal small tools and parts, theft being quite common in some sections.

When a tarpaulin is applied properly it looks like a tent roof. It should be draped over the pipe between the front and back safety guards, using this pipe as the ridge pole. The canvas should slope continuously to the edges, leaving no flat places to catch sparks and cinders. The corners should be tied down securely to prevent the wind or the draft from passing trains from blowing it off, as well as to prevent rain from being driven under it.

Opposes Their Use

By F. F. Zavatkay
Supervisor of Welding and Equipment, New York, New Haven & Hartford, New Haven, Conn.

It is true that a tarpaulin protects the deck and engine of a motor car if it is used as a cover when the car is set off of the track, and its use is, therefore, of decided advantage. On the other hand, it has been our experience that the tarpaulin covers are attractive to trespassers, and particularly so to drivers of motor trucks, who can always use a good piece of heavy canvas, for which reason many of them were stolen, especially from cars that were set off the track where there is a parallel highway. Peculiarly enough, many were also stolen by boys who wanted them for various reasons. In these ways we lost not a few of the tarpaulins at points where it was difficult to observe them.

Tarpaulins are cumbersome to handle and take up considerable room on the car while running, and it was not uncommon for gangs to leave them at the car houses instead of taking them along and using them for the purpose for which they were intended. Again, we had numerous cases where tarpaulins in service caught fire from locomotive sparks and were destroyed, the cars also being damaged in several instances.

While we believe that it is of considerable advantage to protect motor cars while not in use, for the several reasons cited we came to the conclusion that this can be done better in some other way than by the use of tarpaulins. We have, therefore, equipped most of our section cars with permanent canopy tops, which include light wooden frames, waterproofed canvas tops, roll side curtains and windshields. This arrangement not only protects the cars when idle, but it also protects the men when riding on them.

Cost Can Be Justified

By P. A. Starck
Assistant Signal Supervisor, Sioux City, Iowa

When motor cars are set off of the track they should be covered to protect them against the weather. Section and other cars assigned to restricted territories should be kept in the car houses at night. Cars that are expected to be idle for a considerable time should also be housed, not only to protect them from the elements but also to prevent malicious damage and theft of parts.

Obviously cars that are assigned to floating gangs cannot be kept indoors at night. A tarpaulin of ample dimensions will provide protection for such cars both over night and while idle during the day. Experience indicates that in the absence of other shelter, the cost of providing tarpaulins can be justified on several grounds. Any one who has tried to start a track motor car after a severe rain storm knows the value of such protection, since it will keep the wiring and ignition system dry. A car that is kept dry will have a longer life than one that is constantly exposed to sun and rain and snow. Where operators are required to be systematic about the protection of their cars they will almost invariably take better care of them in other respects. Again, it is observed that less accidents occur when cars are kept in good condition.

Making the Paint Inspection

When should the inspection be made to determine next year's painting requirements? Who should be in charge and who should accompany the inspection party? What details should be observed?

Painting Is Seasonal

By G. H. Tinker
Bridge Engineer, New York, Chicago & St. Louis, Cleveland, Ohio

Inspections to determine next year's painting requirements should be made in connection with the annual inspection made by the bridge and building engineer, or engineers. In some cases this may be combined with the chief engineer's annual inspection. The supervisors of bridges and buildings and the division inspectors should accompany the party over their respective districts.

A complete record should be made of the extent of the deterioration of the paint, and notes taken to show whether the individual structures should be repainted or whether spot painting only is required. If the paint film is broken, mention should be made of the number and size of the breaks and whether rust has progressed on steel surfaces. Again, it may be desirable to paint the structure because the paint has become dirty and discolored, even where the film has not broken; in other words, for appearance.

Painting is a season operation, and the paint gangs on the divisions should be kept busy during the period of seasonable weather. The individual gang should be of such size as will permit it to cover its division in about five or more years, depending on the frequency with which the standards of the road requires that the painting be done. If five years is the period chosen, the gang should be of the proper size to cover one-fifth of the division every year. The structures will then be painted in order as the work progresses. If certain structures do not need painting, that is, if the life of the paint exceeds the normal life, these structures can be passed over and included in the following year's schedule.

The fact that a structure needs painting does not of necessity mean that it will be painted during the following season's work. It may be two years before the gang reaches it, especially if the out-of-face plan is followed. If any structure has a few breaks in the paint film while the remainder of the paint is in good condition, it will be patch painted. Under another system, the gang may be scheduled to cover the entire mileage of the division, painting in full or patch painting such structures as are programmed.

After Work Is Completed

By A. L. Sparks
Architect, Missouri-Kansas-Texas, St. Louis, Mo.

Logically, it seems that the best time to make an inspection to determine next year's painting requirements will be as soon as practicable after the current year's painting program has been completed. In any event, it should be made in ample time to make all necessary arrangements for starting the work at the beginning of the season. Inside painting can be done at almost any time, regardless of the weather, except for the highest class of varnish and finish work which must be kept free from dust.

Outside painting cannot be done successfully on wet surfaces or in the glare of the hot midsummer sun. In general, the best months for outside painting will be from April to November, inclusive, except July and August. For this reason, December is the best time for making the paint inspection, except in northern sections where an earlier date may be preferable.

The inspection should be in charge of the district engineer, assisted by the bridge and building supervisor and the master painter. The latter should have a record of the painting of each structure, showing the last previous painting, what work was done and what materials were used. Any unusual variation of conditions should be recorded to determine the suitability of different materials and practices for each kind of work. Careful consideration should be given to the condition of the surface on which the paint is applied to insure that deterioration is not going on beneath the paint film.

As an example, completely undermined surfaces may be found in unsuspected places, caused by termite attack, for these insects rarely cut through paint. Examination should be made of the condition of the nails and nailing in old wooden structures. Rusted and broken nails should be replaced and loose joints made tight before painting the structure.

Leaks should be watched for carefully, and the causes of all defects in the paint should be examined closely to prevent repetition of failures. Open cracks in exterior woodwork should be noted with the view of clearing them of all decay and filling them before the paint is applied. Likewise, corrosion of metal surfaces should be noted so that provision can be made for cleaning them before painting.

Cleaning Pressed Brick Walls

What practical method can be employed to clean the surface of a pressed brick wall?

Use Muriatic Acid

By W. E. Tillett
Assistant Foreman, Chesapeake & Ohio, Maysville, Ky.

If the wall is to be cleaned of efflorescence, muriatic acid is the best cleaning agent. Efflorescence consists of salts of sodium, potassium or magnesium, any one or all of which may be present. The cause of these deposits need not be discussed further than to say that they are leached from the mortar and brick and are deposited on the surface as the water which bears them evaporates.

For cleaning the wall surface, the concentrated acid should be diluted with 20 parts of water and applied with a swab. As the surface is cleaned it should be washed thoroughly with clean water and allowed to dry. Because of this requirement, it is obvious that the cleaning should start at the top and work down.

After the cleaning is completed and the walls are perfectly dry it is well to coat them with a water retardant, to prevent entrance of the moisture which causes the leaching. Boiled linseed oil is particularly adapted for this coating as it is clear and does not stain the surface. Two coats should be applied, and after the second coat has hardened the entire sur-

face should be washed with weak ammonia. This protection should be effective from two to four years, depending on the climate, after which an additional coat can be applied, but the surface should be washed thoroughly before it is put on.

Requires Experience

By Frank R. Judd
Engineer of Buildings, Illinois Central, Chicago

The cleaning of brick walls, particularly pressed-brick surfaces, is a class of work that should not be allowed to be done by inexperienced persons, but should be put in the hands of those who are known to be skilled in work of this character. To obtain good results, an acid solution must be used, and unless this solution is of the proper strength for the texture of the surface to be cleaned, the acid is likely to drive the dirt into the pores of the surface, leaving a streaked and unsightly appearance. For these reasons, it is suggested that work of this kind be performed only by concerns which specialize in cleaning brick and stone surfaces, provided they are known to be dependable and can be relied on to guarantee the workmanship and results on the completed job.

Hydrated Lime in Concrete?

What are the advantages and disadvantages of using hydrated lime in concrete? How much lime should be added?

Degrades Concrete

By M. Hirschthal
Concrete Engineer, Delaware, Lackawanna & Western, Hoboken, N.J.

Hydrated lime was probably the earliest admixture used in concrete for the purpose of improving its quality. It is true that the use of salt antedates hydrated lime, but it was added as an anti-freezing ingredient and not to improve workability or assure water-tightness. The addition of hydrated lime to concrete was for the purpose of improving workability, especially when broken stone was used as coarse aggregate, and to effect water tightness, principally for the latter reason.

In the early days of concrete construction on the Lackawanna, hydrated lime was used in concrete for station foundations, elevator pits, etc., mainly for the purpose of making the walls and floors water tight. In these cases, the addition amounted to five per cent, by volume, of the cement content of the concrete. Later, a series of tests was conducted in the company's laboratory at Scranton, Pa., to determine the effect of this admixture on the strength and other qualities of the concrete. These tests indicated that there was a considerable loss in compressive strength in the test specimens containing the hydrated lime, as compared with others made from the same concrete mixture without the addition of lime.

It was also determined that water-tightness and the same improvement in workability could be obtained without the use of hydrated lime, by the addition of cement equal to the amount of hydrated lime that was being used, provided the water-cement ratio was not changed. The reduction in compressive strength which developed in the test specimens immediately precluded the use of hydrated lime in the concrete which was to be used in members where strength was an important factor. As a result of these tests the use of hydrated lime as an admixture for concrete was discontinued.

The findings from these tests were fully corroborated by the tests conducted by Dr. Abrams, the results of which were published in a research bulletin after four years of investigation, under the title Effect of Hydrated Lime and Other Powdered Admixtures on Concretes. Professor Abrams' research included quantitative as well as qualitative tests, while the Lackawanna tests were with five per cent admixtures only. Professor Abrams' conclusions which were drawn from these tests will bear repetition:

"One per cent of hydrated lime, in terms of volume of cement, reduced the compressive strength of the concrete by 0.5 per cent, but 1 per cent by weight, reduced the strength by 1.2 per cent. Replacing the cement by an equivalent volume of hydrated lime reduced the strength of the concrete by 1¾ times that resulting from the addition of hydrated lime.

"The wetter the mix, the greater was the loss of compressive strength, caused by the addition to the mix of hydrated lime.

"The bond resistance with reinforcing steel was affected in the same manner as the compressive strength, by the addition of hydrated lime."

Depends on Objective

By Assistant Engineer of Bridges

Whether the use of hydrated lime in concrete is advantageous will depend on the result sought, the character of the aggregates, the richness of the mixture and other factors, including the relative cost of the lime and cement. It is important to know the effect of the admixture on the strength of the concrete. Extensive tests have shown (Proceedings American Concrete Institute, vol. 30, p. 325) that to obtain equal strength, as compared with plain concrete, if the concrete contains 400 lb. of cement to the cubic yard, 2 lb. of hydrated lime must be substituted for every pound of cement displaced, up to a maximum admixture of 80 lb. Thus, if the cement content of the concrete mixture is reduced by 25 lb., to 375 lb., it will be necessary to add 50 lb. of lime to obtain the same strength as that of the original plain mix.

As the richness of the mixture increases, the discrepancy between the lime and the cement increases more rapidly. Thus, if the concrete contains 500 lb. of cement, it will require 8.3 lb. of lime to replace 1 lb. of cement, provided the strength of the concrete is not to be reduced. If, as before, the cement is reduced 25 lb., to 475 lb., it would be necessary to substitute 208 lb. of lime.

Probably the reason advanced most often for the use of hydrated lime is its effect on workability. In the same set of experiments it was found that 1 lb. of lime had the same effect on workability as 1.76 lb. of cement. In other words, the same workability was obtained in mixtures containing 400 lb. of cement and 57 lb. of lime as in mixtures containing 500 lb. of cement without any lime. On the other hand, the strength of the latter concrete was 4,000 lb., and of the former only 3,000 lb., a loss of 25 per cent.

When considering the use of hydrated lime, it should not be overlooked that much can be done to improve workability by using sand that is properly graded and contains from 10 to 15 per cent of particles that will pass a 50-mesh sieve. Likewise, proper grading of the coarse aggregate will have the same effect, while equal importance attaches to the relative proportions of coarse and fine aggregate. Proper attention to these factors will often eliminate the need

for an admixture. If, however, a properly graded sand is not available, the addition of hydrated lime may be desirable to avoid the use of mixes excessively rich in cement.

Hydrated lime is not a waterproofing material, and it will increase water-tightness only as it improves the workability of harsh mixes, thereby preventing pockets and voids.

Gage Rods on Main-Line Curves

Under what conditions should gage rods be applied on curves on main-line tracks? What are the advantages? What is the minimum degree of curve upon which it is economical to use them?

Affects Line and Surface

By W. H. Sparks
General Inspector of Track, Chesapeake & Ohio, Russell, Ky.

As a general statement, gage rods should be applied on every curve where trouble is experienced in holding it to gage. Obviously, this statement puts no limit on the minimum degree of curvature and apparently ignores the matter of economy which is raised in the question. This is done deliberately, however, the reason being that any widening of the gage affects both line and surface, while the defects thus created in these elements continue to give trouble, even though the track may be regaged from time to time. Regaging always damages ties and the more often it is done the greater the eventual damage, for tie destruction from this cause progresses at an increasing rate.

Obviously, one of the important advantages resulting from the use of gage rods is the conservation of tie life, because it reduces the amount of gaging that would have been necessary otherwise, and this in turn reduces the damage to the ties which cannot be avoided when gaging and regaging. The life of ties on curves on lines where the power is heavy and the traffic is dense is relatively short at best, as compared to tangent track. The cost of the gage rods necessary to prevent widening of the gage is small, as compared to the value represented by the increased life of the ties which should result from their use. This points to the desirability of installing them on any curve, regardless of the degree of curvature, where trouble is being experienced in holding the track to gage.

There is also another factor that should not be lost sight of, namely, that there is less wear on and damage to the rail where the track is kept to good gage than where the gage is allowed to become wide or irregular. While it is difficult to evaluate this item it is of considerable consequence on lines of heavy traffic.

In considering the use of gage rods and in the maintenance of the curve after they have been applied, it should not be assumed that they are capable of resisting all of the lateral stresses induced by the pressure of the wheel flanges. In other words, the curve should be given the same attention to insure that the rail fastenings are functioning as if gage rods had not been applied. The rail fastenings are designed to offer resistance to these forces at every tie, while ordinarily not more than four, or at most six, gage rods will be needed to the panel. If six gage rods are not sufficient to overcome the trouble, it may be better to install an inside guard rail, although this can be determined only after a study of the conditions has been made on the ground.

Decreases Maintenance

By P. O. Ferris
Assistant Engineer Maintenance of Way, Delaware & Hudson, Albany, N.Y.

Gage rods should be used wherever operating conditions are such that there is an undue tendency for the track to spread, thus causing injury to the ties and resulting in wide gage. Among the advantages of their use, they decrease maintenance because they reduce or eliminate the labor costs that would otherwise be required for gaging, lining, surfacing and renewing damaged ties, while there is also a saving in ties and spikes.

The question as to the minimum degree of curve upon which it is economical to use gage rods cannot be answered specifically because many factors are involved. The maximum degree of curve is that which, because of operating conditions, would require so many gage rods that it would be more advantageous to use an inside guard rail. In this connection we have one 14 deg. curve on our main line where gage rods are used to very good advantage.

Signal circuits introduce a complication which requires the use of insulated gage rods. Where this occurs, the insulation should be inspected frequently to avoid trouble due to signal failures.

Six Degrees Usual Limit

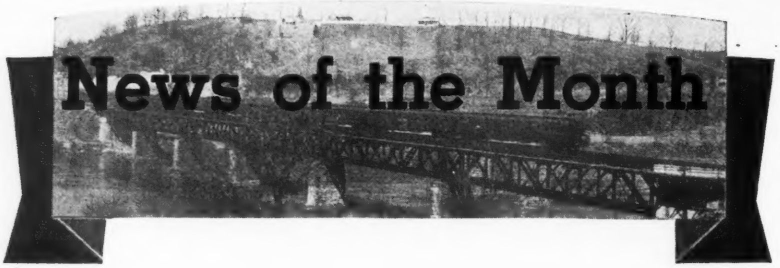
By Division Engineer

Gage rods should be applied on curves of 6 deg. and sharper, on all main-line track, particularly where heavy motive power is in use. They reduce very materially the gaging that would otherwise be required, even with hardwood ties. Obviously, the purpose of the gage rod is to prevent widening of the gage and the resulting hazard of derailment.

Incidentally, and this is not the least of its advantages, the gage rod, by holding the rails against lateral movement under the thrust of the wheel flanges, reduces greatly the amount of gaging and the resulting damage to the ties from excessive respiking. In the majority of cases this alone is sufficient economic justification for their use.

The number of gage rods that should be applied to a 39-ft. rail will vary with the weight of the power in use, the density of the traffic and the speed of trains, especially as the difference between the highest and the lowest speeds varies, and with the relative number of hardwood and softwood ties. It is suggested that as ordinary practice four gage rods are sufficient for a 6-deg. curve and six for a 10-deg. curve where the rail is 90-lb. or heavier. In signaled territory, of course, insulated rods must be used.

After the gage rods have been installed, the ties in the curve should be watched carefully, to avoid the possibility that all of the stress will not be taken by the gage rods. It has proved to be decidedly economical to install gage rods on No. 8 turnouts, on wye tracks and on back tracks in yards and elsewhere where there is considerable movement of heavy locomotive power.



Increased Car Loadings Expected in Fourth Quarter

Freight car loadings during the fourth quarter of 1936 are expected to be about 9.7 per cent above actual loadings in the same quarter in 1935, according to estimates compiled by the thirteen shippers' regional advisory boards. On the basis of these estimates, freight car loadings of the 29 principal commodities will be 5,603,186 cars in the fourth quarter of 1936, compared with 5,107,030 cars for the same commodities in the corresponding period in 1935. Each of the advisory boards estimates an increase in the loadings for the fourth quarter of 1936 compared with the same period in 1935. The largest increase (20.9 per cent) is expected to take place in the Great Lakes region, while the smallest (0.4 per cent) is anticipated to take place in the Central Western region.

Rock Island to Buy Six Streamlined Trains

The latest railroad to enter the market for streamlined trains on a large scale is the Chicago, Rock Island & Pacific which, subject to the approval of the Federal District Court and the Interstate Commerce Commission, will purchase six light-weight streamlined trains at a cost of approximately $2,250,000. To determine the type of equipment to be purchased, alternate bids have been asked on aluminum and stainless steel and Diesel electric and steam motive power for three- and four-car trains. The plans, which are not yet fully developed, provide for the operation of one train between Chicago and Peoria, Ill., on a roundtrip schedule of 2 hr. 45 min. in each direction; one train between Chicago and Des Moines, Iowa, on a roundtrip schedule of 6 hr. in each direction; two trains between Kansas City, Mo., and the Twin Cities, on a schedule of 8 hr.; and two trains between Kansas City and Denver, Colo., on a schedule of 11 or 12 hr. It is planned to place the new trains in service early in 1937.

Railway Net in August up 53 Per Cent

For August, 1936, the Class I railroads of the United States earned a net railway operating income of $64,680,717, which was at the rate of return of 2.28 per cent on their property investment, according to reports compiled by the Bureau of Railway Economics of the Association of American Railroads. This was an increase of 53.4 per cent over August, 1935, when the net was $42,156,706, or 1.48 per cent. Operating revenues for August amounted to $350,584,820, compared with $293,989,543 in August, 1935. Operating expenses totaled $246,299,475, as compared with $221,353,466.

For the first eight months of 1936 these roads had a railway operating income of $364,697,978, a return of 2.30 per cent, as compared with a net of $263,852,503, and a return of 1.66 per cent in the comparable period of 1935. Operating revenues for the first eight months of 1936 totaled $2,573,257,647, compared with $2,204,833,031 for the same period in 1935. Operating expenses for these months amounted to $1,916,048,550, as compared with $1,699,321,769 for the same period in 1935.

Railway Purchases Continue Upward Trend

Continuing the upward trend which has been evident for some time, railway purchases of materials, supplies and fuel in August totalled $67,500,000, according to preliminary estimates, as compared with purchases of $46,000,000 in August, 1935. The total in August, 1932, was only $30,000,000. These figures do not include purchases of new locomotives and cars or purchases by contractors for railway work. Railway purchases from manufacturers are now averaging 60 per cent larger than in 1935 and over 100 per cent more than in 1933.

During the eight months ending August 31, expenditures by the railroads for materials, supplies and fuel and the value of orders placed by them with equipment builders for new locomotives and cars reached the imposing sum of $597,000,000, according to present calculations. This includes $341,577,000 for materials and supplies purchased from manufacturers and $88,987,000 of equipment orders. The remaining $166,439,000 was spent for coal and fuel oil.

New Zephyr Breaks Chicago-Denver Record

A new speed record for the run between Chicago and Denver was established on October 23 when one of the new Denver Zephyrs of the Chicago, Burlington & Quincy, in a westbound run between these points, traversed the 1,017.22 miles in 12 hr. 12 min. 27 sec., or at an average speed of 83.3 miles per hour. The previous record for this run, which was held by the original Zephyr, was established on May 26, 1934, when that train travelled 1015.4 miles from Denver to Chicago in 13 hr. 5 min., or at an average speed of 77.6 m.p.h. While the earlier run was made over predominately descending grades, the Denver Zephyr had to climb nearly a mile in making its record-breaking run. The maximum speed attained on the recent trip was 116 m.p.h. near Brush, Colo., while at another point an average speed of 105.8 m.p.h. was maintained for 26.6 consecutive miles.

The Denver Zephyr, which is one of two high-speed streamlined Diesel-electric trains to be built by the Edward G. Budd Manufacturing Company for the Chicago-Denver service of the Burlington, carried two power cars and six trailers on its record run, while the original Zephyr consisted of a power car and two trailers. On November 7 both of the new Denver Zephyrs will be placed in daily over-night service between Chicago and Denver on 16-hr. schedule each way.

Number of Grade Crossings Reduced

Fewer highway-railroad grade crossings were in existence on January 1, this year, than on any similar date in the past ten years, according to an announcement by the Association of American Railroads. On that date the number of highway-railroad grade crossings in existence in this country totalled 234,231, as compared with 242,809 (the greatest number on record) on January 1, 1930, a reduction of 8,578. Part of the reduction can be attributed to the grade-crossing elimination program adopted by the government as a means of promoting unemployment relief. The Bureau of Public Roads of the Department of Agriculture estimates that by the time the present program has been completed more than 3,000 grade crossings will have been eliminated.

I. C. Inaugurates Employee Training Course

An employee training program involving lectures and correspondence training courses, the first to be undertaken on a large scale by any railroad, was inaugurated by the Illinois Central on October 2, with a total voluntary enrollment of more than 1,000 employees representing practically every department in the railway organization. This training program, which is designed to cover a one-year period, will be carried on under the personal direction of Dr. Thor W. Bruce, assistant to the dean of the College of Commerce and Finance of the University of Illinois. It is so arranged that the 561 employees enrolled in and near Chicago will be able to attend lectures, and that the 545 who are prevented by distance from attending the lectures may take correspondence courses. Lectures on general subjects will be given on Friday evenings, while discussions of railway subjects by railroad officers will be held on Saturday mornings. The latter meetings will consist of two sessions, the first comprising the lecture on some technical feature of railroading while at the second session Dr. Bruce will direct a class room discussion of the points covered in that lecture and on the one on fundamentals that was delivered the preceding evening.

Association News

Metropolitan Track Supervisors Club

Forty members and guests attended the first fall meeting of the club at the Hotel McAlpin, New York City, on October 22. Following dinner, the meeting took the form of a round-table discussion of problems encountered in "reconditioning of rail joints and rail ends."

Maintenance of Way Club of Chicago

The Railway Outlook was the subject of an address by Samuel O. Dunn, chairman of the Simmons-Boardman Publishing Company and editor of the Railway Age, at a meeting of the club on October 26, which was attended by 80 members and guests. At the next meeting, on November 23, C. H. Longman, assistant to the vice-president and general manager of the Chicago & North Western, will address the club on the subject of Safety.

Wood Preservers Association

The executive committee met in Chicago on October 21, to complete arrangements for the thirty-third annual convention, which will be held at the Hotel Roosevelt, New Orleans, La., on January 26-28. The committee approved plans for the operation of a special train from Chicago to New Orleans via the Chicago & Eastern Illinois-Louisville & Nashville railways, with connecting cars from New York and from St. Louis, Mo., joining the party at Terre Haute, Ind. The party will stop at Terre Haute and also at Montgomery, Ala., and Mobile to inspect timber treating plants, arriving in New Orleans Monday evening.

American Railway Engineering Association

The Association of American Railroads has issued a book containing the A.R.E.A. rules for the location, maintenance and operation of track scales. It also includes the A.R.E.A. specifications for knife-edge scales of the 2 and 4-section types; for motor truck, self-contained and portable scales; and for overhauling and repairing large-capacity scales.

The Board of Direction and the Nominating committee will meet in New York on November 5.

Thirteen committees held meetings during October, including those on Economics of Railway Operation, at Cleveland, Ohio, on October 2; Masonry, at Chicago, on October 8 and 9; Iron and Steel Structures, at St. Louis, Mo., on October 8 and 9; Ballast, at New York, on October 16; Yards and Terminals, at Louisville, Ky., on October 19 and 20; Shops and Locomotive Terminals, at Detroit, Mich., on October 19 and 20; Ties, at St. Louis, Mo., on October 21; Waterways and Harbors, at Chicago, on October 21; Highways, at Chicago, on October 21; Wood Preservation, at Chicago, on October 22; Water Service, Fire Protection and Sanitation, at Chicago, on October 23; Uniform General Contract Forms, at Norfolk, Va., on October 26; and Records and Accounts, at Chicago, on October 27.

Four committees have also scheduled meetings for November, as follows; Economics of Railway Location, at New York, on November 6; Buildings, at Savannah, Ga., on November 12 and 13; Economics of Railway Labor at Dallas, Tex., on November 17-18; and Track, at Chicago, on November 18.

Up to the first of the month, three committee reports have been placed in the hands of the secretary and a fourth is completed and ready for transmittal.

25,000,000 Meals Served Annually in Diners

Approximately 25,000,000 meals a year are prepared and served on trains to appease the appetites of the traveling public, according to a statement issued by the Association of American Railroads. When it is considered that these meals must be served from dining car kitchens less than 7 ft. wide and 16 ft. long, the immensity of the task becomes readily evident. From experience, according to the statement, the steward knows that of every hundred patrons about 85 will want coffee and 15 tea. About 35 will ask for roast beef while the remainder will order chicken, fish, chops and steaks, in about the order named. The most popular dessert is apple pie. Meals served in railroad dining cars annually require about 15,000,000 lb. of meat, 1,000,000 lb. of coffee, 250,000 lb. of tea, 2,000,000 doz. eggs, 1,125,000 loaves of bread, 30,000,000 rolls, and 2,000,000 lb. of butter.

Prospective Employees Given Training on K.C.S.

A pre-employment training school, designed to aid in the selection of employees and to give prospective employees a background of railroad knowledge, has been established by the Kansas City Southern. The pre-employment schooling is carried on daily except Saturday and Sunday in the Kansas City Southern building at Kansas City, Mo., the class-room hours being from 8:30 a.m. to 4:30 p.m., with a lunch period. The teaching method follows advanced practice, alternating reading and study periods with lectures that are facilitated by chalk talks and charts. Lectures by the instructor are supplemented by talks delivered by representatives of the various departments. Young men accepted for the training must come as high school graduates with an upper 10 per cent scholastic standing. They must first submit to a series of tests, undergo a physical and medical examination and an investigation of record and background. Personality plays a part. Students who apply for admission and are accepted are informed that a place in actual service is not guaranteed, but that they will be given preference over other applicants.

Personal Mention

General

F. W. Biltz, assistant division engineer on the Reading, with headquarters at Reading, Pa., has been promoted to assistant to general superintendent, with the same headquarters. Mr. Biltz was born on August 15, 1892, at Ashland, Pa., and was graduated from Lafayette College in 1917, with the degree of Civil Engineer. He entered railway service on June 18, 1917, with the Reading Company as a levelman at the Reading terminal in Philadelphia, Pa., and on July 25, 1917, he was promoted to assistant supervisor on the Shamokin division, with headquarters at Tamaqua, Pa. On February 25, 1918, he left railway service to join the railway engineers of the A.E.F. in France, serving as second and first lieutenant. On July 29, 1919, he returned to his former position as assistant supervisor at Tamaqua, and later served in this capacity at Reading, and at Trenton Junction, N. J., until July 1, 1922, when he was promoted to supervisor on the New York division, with headquarters at Olney, Pa. Subsequently, Mr. Biltz held this position on various divisions of the road, having headquarters at Mahanoy Plane, Pa., Pottsville, Pa., and Pottstown, Pa., where he was located at the time of his recent promotion to assistant to general superintendent.

Engineering

W. H. B. Bevan, assistant district engineer on the Central region of the Canadian National, with headquarters at Toronto, Ont., has been appointed division engineer of the Montreal, (Que.) Terminals, to succeed **G. H. Frith,** who has been appointed office engineer at Toronto.

Track

H. H. Leathers, roadmaster on the Portage-Brandon division of the Canadian National, with headquarters at Portage La Prairie, Man., has been transferred to Brandon, Man., to succeed **T. Muirhead,** who has been transferred to Portage La Prairie, to succeed Mr. Leathers.

Millard DeGroat, section foreman on the New York Central, has been promoted to assistant supervisor of track on the Catskill Mountain division, with headquarters at Kingston, N. Y., succeeding **David DeGroat,** who has been transferred in the same capacity to the main line of the River division with headquarters, as before, at Kingston.

F. G. Davey, roadmaster of Division "A" of the Clover Leaf district of the New York, Chicago & St. Louis, with headquarters at Delphos, Ohio, has retired from active duty after 55 years service with this company. Coincident with

Mr. Davey's retirement, roadmasters' territories on this district were rearranged, reducing the number of roadmasters from four to three.

H. K. Modery, assistant supervisor on the Reading, with headquarters at Lansdale, Pa., has been promoted to supervisor of track, with headquarters at Reading, Pa. Mr. Modery is succeeded as assistant supervisor at Lansdale by **H. L. Locke,** formerly draftsman in the chief engineer's office, at Philadelphia, Pa.

Darel DeVore, track foreman on the Ft. Wayne division of the Pennsylvania, has been appointed acting supervisor on the Toledo division, with headquarters at Toledo, Ohio, to succeed **H. D. VanVranken,** disabled. **A. W. Miller,** assistant supervisor on the Baltimore division has been promoted to supervisor on the Grand Rapids division, with headquarters at Petoskey, Mich., to succeed **J. H. Ault,** who has been transferred to the Indianapolis division, with headquarters at Jeffersonville, Ind., where he replaces **W. W. Clark.** Mr. Clark has been transferred to the Ft. Wayne division, with headquarters at Warsaw, Ind., to succeed **C. W. Light,** disabled.

Pat Moyers, whose appointment as track supervisor on the Illinois Central, with headquarters at Vicksburg, Miss., was reported in the October issue, was born on December 3, 1884, at Pelahatchie, Miss. He entered railway service on December 3, 1907, as a section laborer on the Alabama & Vicksburg (now part of the Illinois Central), being advanced to section foreman on May 1, 1908. Three years later he was further promoted to extra gang foreman and on January 1, 1919, he was appointed foreman of the Vicksburg, Miss., yard. On April 1, 1926, Mr. Moyers was promoted to supervisor of track, holding this position until April 1, 1931, when, as the result of force reductions, he returned to the position of foreman in the Vicksburg yard. His reappointment to the position of track supervisor at Vicksburg became effective on September 1.

Mahlon E. Spivey, who has been appointed roadmaster on the Atchison, Topeka & Santa Fe, with headquarters at Parker, Ariz., as reported in the October issue, was born on March 10, 1887, at Waldo, Miss. Mr. Spivey entered railway service on December 11, 1907, with the Southern Pacific, serving as a trackwalker, section foreman, extra gang foreman and foreman of rock quarries and gravel pits. During the war Mr. Spivey, expecting to be called to the service, took a year's leave of absence and later engaged in farming and stock raising. In November, 1921, he returned to railway service as a section foreman on the Santa Fe. In February, 1922, he was appointed an extra gang foreman and continued in this capacity and in charge of gravel pits and rock quarries until February, 1927, when he was made acting roadmaster at Gallup, N.M. Thereafter he served as acting roadmaster, assistant roadmaster, and section foreman at various points, until his recent promotion to roadmaster at Parker where he had been serving as acting roadmaster.

Bridge and Building

W. S. Stickelman, a bridge foreman on the Chicago Great Western, has been appointed supervisor of bridges and buildings of the Illinois and Iowa divisions, with headquarters at Oelwein, Iowa, to succeed **Nels Johnson,** who has resigned.

M. J. J. Harrison, general inspector of scales of the Pennsylvania at Chicago, has been promoted to supervisor of scales and weighing, with headquarters at Altoona, Pa., to succeed **Alonzo W. Epright,** who retired from active duty on September 30.

Mr. Harrison was born on March 12, 1893, as Wellsboro, Pa., and was graduated from Rennsselaer Polytechnic Institute in 1913, with a degree in civil engineering. He entered railroad service on July 15, 1920, with the Pennsylvania as general scale inspector of the Western region at Chicago, which position he held until his recent appointment as supervisor of scales and weighing. Mr. Harrison has been chairman of the Committee on Yards and Terminals of the American Railway Engineering Association since 1933, and has also been active in the work of other committees of this association since he became a member in 1925.

Mr. Epright entered the service of the Pennsylvania on July 12, 1891, in the mechanical department and, after several years as a gang foreman, was promoted to foreman of the tool department on June 6, 1896. On July 1, 1901, he was promoted to general scale inspector of the Pennsylvania lines east of Pittsburgh and Erie, Pa., which position he held until May 1, 1920, when he was promoted to supervisor of scales and weighing of the Pennsylvania system. Throughout his long career with the railroad, Mr. Epright was closely associated with the design, manufacture, installation and maintenance of all types of scales used by the road. He is a member of the Committee on Weighing of the Traffic department of the Association of American Railroads, and for many years was connected with the American Railway Association as chairman of its Committee on Standards, which, under his direction, developed the first specifications for track scales in America. He was also chairman of the so-called Aishton committee, which later revised these specifications, which were subsequently adopted by the American Railway Association, the National Bureau of Standards, the Interstate Commerce Commission, and the Scale and Balance Manufacturers' Association.

Alonzo W. Epright

H. F. Turnbell, assistant supervisor of bridges and buildings of the Lake Erie and Western district of the New York, Chicago & St. Louis, with headquarters at Tipton, Ind., has been promoted to supervisor of bridges and buildings of the Clover Leaf district, with headquarters at Frankfort, Ind., to succeed **J. B. Kelly,** who has retired after 38 years of service with this company. **Joe Hazelwood** has been appointed assistant supervisor of bridges and buildings on the Lake Erie and Western district, to succeed Mr. Turnbell. These changes became effective on September 16.

W. F. Birkelbach, supervisor of bridges and buildings on the Pocahontas division of the Norfolk & Western, with headquarters at Bluefield, W. Va., has been retired from active duty following 34 years of service with the company. Mr. Birkelbach, who was born on August 19, 1866, at Pottsville, Pa., entered the servive of the Norfolk & Western on July 12, 1902, as a carpenter. On January 1, 1903, he was promoted to assistant carpenter foreman, and on July 1, 1904, he was advanced to carpenter foreman. He was promoted to supervisor of bridges and buildings on January 6, 1921.

R. W. Cook, master carpenter on the Seaboard Air Line, with headquarters at Atlanta, Ga., has been promoted to general bridge inspector, with headquarters at Norfolk, Va., to succeed **James Durkin,** who has retired. **C. H. Burks,** assistant master carpenter at Savannah, Ga., has been promoted to master carpenter at Atlanta, to replace Mr. Cook, and has been succeeded at Savannah by **C. E. Schofield,** assistant division engineer with headquarters at Atlanta.

Mr. Cook was born on August 16, 1896, at Fairburn, Ga., and was educated at the University of Georgia, graduating with a bachelor of science degree in civil engineering in 1917. In 1918 Mr. Cook joined the United States Army and served in France with the base hospital corps. In 1919, following his return from the war, he entered the service of the Georgia highway department and from 1921 to 1923, he served with the North Carolina highway department. At the end of this period he entered the service of the Seaboard Air Line as assistant division engineer at Atlanta, being assigned to the position of assistant master carpenter at the same point in 1928. Four years later he was further promoted to master carpenter at Atlanta, holding this position until his recent appointment as general bridge inspector, which was effective on September 1.

Water Service

J. B. Huckabay has been appointed division water service foreman of the Slaton division of the Panhandle & Santa Fe, with headquarters at Slaton, Tex., to

succeed **Robert A. Swanner,** who has retired. Mr. Huckabay has been connected with the engineering department of this company for the past 14 years.

Obituary

Elliot E. Candee, retired supervisor of bridges and buildings on the New York, New Haven & Hartford, at Waterbury, Conn., died on September 27.

Elmer F. Anderson, assistant supervistor of track on the New York Central, with headquarters at Lyons, N. Y., died on October 13, at his home in Lyons.

Herman H. Ueckert, supervisor of structures of the Southern Pacific Lines in Texas and Louisiana, died on September 29 at the general hospital in Houston, Tex., following a long illness. Mr. Ueckert had been connected with the Southern Pacific for 37 years. He was born on March 18, 1876, at Altamont, Ill., and obtained his technical education at Texas Agricultural and Mechanical College, graduating in 1897. Two years later Mr. Ueckert entered the service of the Southern Pacific as a junior draftsman and estimator in the bridge and building department in the general offices at Houston. After serving in various capacities, he was advanced to assistant superintendent of the old Beaumont division (now part of the Houston division) in 1916. In November, 1917, he was appointed engineer of structures in the Houston Terminals, holding this position during the time that the railroads were under federal control. When the railroads were returned to their owners at the close of the World War, Mr. Ueckert was appointed supervisor of structures.

Andrew Mahoney, roadmaster on the Missouri-Kansas-Texas, with headquarters at Coffeyville, Kan., who died on August 18 of heart disease, as reported in the September issue, was born in Roodhouse, Ill. In 1888, at the age of about 14 years, Mr. Mahoney first entered railway service as a trackman on the Chicago, Rock Island & Pacific. Later he served in various capacities on a number of railroads until 1900, when he went with the Choctaw, Oklahoma & Gulf (now part of the Rock Island) as a trackman at Oklahoma City, Okla. Three years later he was promoted to yard foreman at Sayre, Okla. In 1904 he went with the Rock Island as a yard foreman at Amarillo, later being advanced to roadmaster. In 1906, Mr. Mahoney entered the service of the Midland Valley, serving as an extra gang foreman and roadmaster at Muskogee, Okla. until 1908, when he was appointed yard foreman at the same point. From 1912 to 1915, he served as a roadmaster on the Midland Valley at Muskogee. At the end of this period he entered the service of the Missouri-Kansas-Texas as a roadmaster at Coffeyville.

Two-Stage Air-Cooled Portable Compressors and Tools—This is the title of a 56-page illustrated catalog issued by the Ingersoll-Rand Company, New York, which gives complete information concerning the portable compressors, pneumatic tools, rock drills, hoists, and other equipment manufactured by this company.

Supply Trade News

General

Linde Air Products Company, a unit of **Union Carbide & Carbon Corporation,** has opened a new district office at 2 Virginia street, Charleston, W. Va. **A. R. O'Neal** has been made district manager.

The **Dearborn Chemical Company** is completing an extension to its main manufacturing plant, located in the Central Manufacturing District, Chicago, which will result in a 16 per cent increase in floor space. This, the third major addition in 12 years, will be used for a modern machine shop and new equipment for increased business. At the same time the laboratories have been remodeled and new equipment installed. Factory offices have been remodeled and air conditioned.

Thes name of **Koppers Gas & Coke Company,** Pittsburgh, Pa., has been changed to **Koppers Company,** and three subsidiary companies have been or will be dissolved and will become divisions of the parent company. They are The Koppers Construction Company, which becomes the Engineering and Construction division; Koppers Products Company, which becomes the Tar and Chemical division, and the Bartlett Hayward Company, which becomes the Bartlett Hayward division. The Western Gas division of the Koppers Construction Company becomes a division of Koppers Company as does the American Hammered Piston Ring division of the Bartlett Hayward Company. The Maryland Drydock Company, the White Tar Company of New Jersey, Inc., and the Wood Preserving Corporation remain as subsidiaries of Koppers Company. Officers of the former subsidiaries will become officers of Koppers Company. To avoid similarity of titles, the name of the Koppers Company, parent company of Koppers Company, will be changed to Koppers United Company.

Personal

W. L. Keady, vice-president in charge of operations of the **United States Gypsum Company,** has been appointed vice-president in charge of sales, and **L. H. Atkinson,** assistant to the vice-president, has been made general sales manager.

Frank P. McEwen, formerly southern sales manager of the Oliver Iron & Steel Corp., has been appointed assistant manager of sales, with headquarters at Cleveland, Ohio, of the **Upson division** of **Republic Steel Corp.** This division is concerned with the manufacture and sale of bolts and nuts. Mr. McEwen was born at Nashville, Tenn., and his first connection was with the Nashville, Chattanooga & St. Louis in the freight department. He left there in 1912 to become commercial agent in charge of solicitation of the Clinchfield Railroad. In April 1917, he enlisted in the Army and was soon commissioned first lieutenant in the 30th Division of the 115th Field Artillery. After spending fourteen months in France, he returned to the Clinchfield Railroad as general western agent. In 1928, he was appointed district

Frank P. McEwen

sales manager of the Oliver Iron & Steel Corps., and remained with that company until his recent appointment with the Republic Steel Corp.

Obituary

William T. Watkins, chairman of the board of the Joyce-Watkins Company, and a pioneer producer of railway crossties, died on October 16 at Marietta, Ohio. Mr. Watkins was born in 1860 in Chautauqua County, N.Y., and began his business ca-

William T. Watkins

reer as a purchasing agent of the Minneapolis, St. Paul & Sault Ste. Marie in 1886. In 1897 he became vice-president of the Bradley-Watkins Company and later served as president of the Pillsbury-Watkins Company. In 1906, he became vice-president of the Joyce-Watkins Company, Chicago, and in 1909 he was elevated to the presidency of this company. Since 1932 he had been chairman of the board. At the time of his death he was also president of the Watkins Creosoting Company, the Arrow Transportation Company, and a director of the Wyoming Tie & Timber Company.

STATEMENT of the ownership, management, circulation, etc., required by the Act of Congress of March 3, 1933, of RAILWAY ENGINEERING AND MAINTENANCE, published monthly at Chicago, Ill., for October 1, 1936.

State of Illinois } ss.
County of Cook }

Before me, a Notary Public, in and for the State and county aforesaid, personally appeared E. T. Howson, who, having been duly sworn according to law, deposes and says that he is the Editor of the RAILWAY ENGINEERING AND MAINTENANCE and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 411, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher, Simmons-Boardman Publishing Co., 30 Church St., New York, N. Y.
Editor, E. T. Howson, 105 West Adams St., Chicago, Ill.
Managing Editor, Walter S. Lacher, 105 West Adams St., Chicago, Ill.
Business Manager, F. C. Koch, 30 Church St., New York, N. Y.

2. That the owners are:

Simmons-Boardman Publishing Company, 30 Church Street, New York, N. Y.; Simmons-Boardman Publishing Corporation, 30 Church Street, New York, N. Y.; Stockholders of 1 per cent or more of the total amount of stock are: I. R. Simmons, 15 Hillcrest Dr., Pelham Manor, N. Y.; P. A. Lee, Hopatcong, N. J.; Henry Lee, Hopatcong, N. J.; E. G. Wright, 398 N. Walnut Street, E. Orange, N. J.; S. O. Dunn, 105 West Adams Street, Chicago, Ill.; C. E. Dunn, 3500 Sheridan Blvd., Chicago, Ill.; L. B. Sherman, 375 Sheridan Road, Winnetka, Ill.; Mae E. Howson, 105 West Adams Street, Chicago, Ill.; Spencer, Trask & Company, 25 Broad Street, New York, N. Y. General partners of Spencer, Trask & Company are: E. M. Bulkley, Acosta Nichols, Cecil Barret, C. Everett Bacon, William R. Basset, F. Malbone Blodget, Henry S. Allen, Henry M. Minton, William Kurt Beckers, Arthur H. Gilbert, all of 25 Broad Street, New York, N. Y. Percival Gilbert, William E. Stanwood, both of 50 Congress Street, Boston, Mass., are General partners, Henry A. Colgate, 25 Broad Street, New York, N. Y.; Special Partner, and S. Bayard Colgate, Special Partner, 15 Exchange Place, Jersey City, N. J.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

E. T. HOWSON,
Editor.

Sworn to and subscribed before me this 5th day of October, 1936.

ANNE A. BOYD.
[Seal.] (My commission expires Dec. 10, 1939.)

ALPHABETICAL INDEX TO ADVERTISERS

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